THE PLANT DISEASE REPORTER

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Division of Mycology and Disease Survey serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

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THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

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PINK ROOT OF SHALLOT, ALLIUM ASCALONICUM

E. C. Tims

Introduction

The shallot, Allium ascalonicum, is widely grown in the southern portion of Louisiana and is an important truck crop during the fall, winter and early spring in that area. This crop is not important commercially anywhere else in the United States. Shallots have been grown for many years in certain concentrated areas of the State. Continuous cropping year after year in the same fields has made conditions favorable for the development of soil-borne diseases. Pink root, incited by Pyrenochaeta terrestris (Hansen) Gorenz, Walker & Larson, has been one of the serious soil-borne diseases of shallot for a long time. This paper includes a general discussion of the disease with the results of studies and observations made over a period of about ten years.

According to Tiebout and Montelaro (15) 90 percent or more of the shallots grown in the United States are produced in Louisiana. The carlot shipments total from 700 to 1000 cars each year. Most of the shallots are shipped during the period from the early part of October until early May. During the early fall and late spring, temperature conditions are favorable for pink root development. Gorenz, Larson and Walker (6) showed that the optimum temperature for pink root of onion is between 24° and 28° C. Severe pink root damage has been observed on shallot as late as the last of December in southwest Louisiana.

Historical

While shallots have been grown in south Louisiana for many years, the writer has not been able to find records to show how long they have been produced commercially. The published accounts of the occurrence of pink root on shallots are also scarce. Edgerton (4) mentions that pink root of onion has been known in the State since 1909. It seems quite probable that the disease has also been present on shallot at least that long. Apparently the first published account of pink root on shallot was made by Taubenhaus and Mally in 1921 (13). Duplessis (3) mentioned pink root of shallot in South Africa in 1934.

Symptoms

Pink root first shows in the field as a burning of the tips of the leaves. In mild cases this may be the only above-ground symptom. As there are many other factors that may cause burning and dying back of shallot leaves, root symptoms are necessary for positive identification of the disease. Shallot bunches with the leaves killed back one-half to one inch from the tip sometimes have only a few infected roots. As more roots become infected or as the weather turns warm and dry the leaves die back further. Such severely infected bunches usually remain small, stunted, and yellow, and often continue dividing into many small shoots. All stages of infection, from slight dying back of the tips of the leaves to severe stunting and death of the plants, are usually present in a field.

Infection is easy to identify in shallots because of the characteristic pink color of the affected roots. Some bunches have only an occasional "pink" root while practically all of the roots may be affected on others. The diseased roots are a light pink color when first infected; later the color may become darker until the roots are light purple. Bunches severely affected with pink root can be pulled out of the ground very easily because of the weakened root system. Figure 1 shows typical affected bunches with a healthy bunch. When conditions are favorable for shallot growth (cool, with plenty of moisture in the soil) the plants may remain green and normal in appearance even though the roots are moderately affected with pink root. But if conditions are reversed (warm and dry soil) a mild pink root infection may cause severe above-ground symptoms. Many shallot growers think that pink root is caused entirely by dry, warm weather.

Distribution and Economic Importance

Pink root is widely distributed over the principal shallot producing areas in the southern part of the State, especially along the lower Mississippi River and Bayou Lafourche. In 1942 Tims (16) mentions that "practically no fields were found free of the disease."

FIGURE 1. Pink root (Pyrenochaeta terrestris) on shallot in Louisiana. Left, typical affected bunches. Right, healthy bunch.

long the northern portion of the shallot belt infected fields are not so common, although the disease does occur in destructive form in some areas.

Until comparatively recent years pink root has certainly been the most serious disease of shallot. Tims (16) in 1942 writes that "pink root is the most serious disease affecting shallot during the latter part of the growing season." Some fields are so severely affected that shallot growing is no longer profitable (17). The losses from pink root are due principally to 1) the stunting or killing of the affected plants because of injury to the roots and 2) to killing back of the tips of the leaves in such a way as to make the plants unfit for market. The losses due to pink root are difficult to evaluate because of the variation in severity of the disease. During dry periods when there is a scarcity of moisture in the soil a light pink root infection may cause dying back of the tips of the leaves severe enough to make the shallots unsaleable. When soil moisture is plentiful the damage from the disease may be slight. However, there are serious losses from the disease every year, especially during dry spells in the early fall and late spring.

Causal Organism

Taubenhaus and Johnson (12) first gave the name "pink root" to a disease of onion in Texas in 1917. Later Taubenhaus and Mally (13) named the causal organism Fusarium malli. In 1926 Hansen (7) found that a species of Phoma caused pink root of onion. He was unable to reproduce the disease by inoculating with species of Fusarium. Hansen later (8) called the organism Phoma terrestris. In 1948 as the result of a careful morphological study of the pink root organism Gorenz, Walker and Larson (5) changed the name to Pyrenochaeta terrestris. Although Fusarium has been eliminated as the primary cause of pink root, it is quite likely that species of Fusarium have a part in the root rotting associated with the disease.

Host Relations

Most of the cultivated species of Allium, including onion, garlic, leek, shallot, chives and the Nebuka onion (A. fistulosum), are affected by the pink root fungus. According to Porter and Jones (10) the Nebuka onion, chives, and leek showed a marked tolerance to the disease, while many onion varieties, shallot, and garlic were extremely susceptible.

Among other plants known to be susceptible to attack by the pink root fungus, according to Kreutzer (9), are barley, cane, cantaloupe, carrot, cauliflower, corn, cucumber, eggplant,

millet, muskmelon, oats, pea, pepper, soybean, spinach, squash, tomato, and wheat. He stated that in his inoculation tests cane, sorghum, millet, cucumber, carrot, and spinach were severely or moderately affected by P. terrestris.

Thornberry and Anderson (14) reported tomatoes in the Chicago area badly stunted, with roots pink and discolored, apparently due to the pink root fungus. A similar condition was reported in New Jersey in 1941 by Clark (2). Carvajal (1) isolated the pink root fungus from sweet clover, corn, sugarcane, rice, and cotton roots in Louisiana. Sprague (11) in 1943 stated that "on the basis of studies during the past four years it appears that P. terrestris should be recognized as a widespread but minor weak parasite and saprophyte on the underground parts of cereals, many grasses and certain other hosts in North Dakota and adjoining states."

The rather extensive host range of P. terrestris indicates that some care should be used in selecting crops to use in rotation with shallots in pink root infested soil.

Life Cycle on Shallot

Pink root is a soil-borne disease. Once a field has become infested the more often shallots are planted the worse the disease is likely to become. This, however, is not always the case. Some soils may be infested with pink root, and although shallots are grown there year after year the disease apparently becomes little or no worse. However, this is the exception rather than the rule. Shallot sets or green transplants taken from infected fields are likely to carry the disease if used for planting material. The pink root fungus is carried through the summer in the old dry roots attached to the sets. Observations and experiments made over a period of several years show rather clearly that pink root-free planting material may produce a fair yield in infested soil, but infected sets or green transplants in similar soil seldom produce saleable shallots.

Most of the shallots are grown on small farms with insufficient land to permit suitable rotation. For this reason it is especially important to have pink root-free planting material.

Pink Root and Yellow Dwarf of Shallot

Some years ago a shallot seedling was selected by Dr. Julian C. Miller and his coworkers at Louisiana State University that showed a high degree of resistance to pink root. The seedling was large and vigorous, and although it contracted pink root quite readily the infected plants made satisfactory growth. This shallot had become popular with some growers and was being grown rather extensively when another disease entered the picture. The new shallot variety showed unusual susceptibility to yellow dwarf. The plants not only contracted the disease quite readily in the field, but were more seriously injured than those of the common shallot. It was observed, however, that this pink root-resistant shallot when infected with the yellow dwarf virus became more susceptible to pink root. The combination of pink root and yellow dwarf actually killed many plants of this variety. Within a few years after yellow dwarf became widespread in the pink root-resistant shallot, production fell off rapidly and at present it is not grown commercially.

Control Measures

Use of Disease-Free Planting Material. One of the early recommendations for reducing pink root in shallots was the growing of sets in areas free of the disease. Seed producing areas were established on the northern border of the shallot belt where the crop had not been grown long and where the disease had not become established. This procedure reduced the amount of infected seed brought into the principal shallot producing areas, but after a few years pink root gradually became established in some of the seed producing areas. This necessitated moving to new non-infested fields.

The early shallot plantings are made with dry sets or bulbs produced the previous spring and stored during the summer. These early plantings usually begin late in August and continue through October. When conditions of temperature and moisture are favorable the shallots grow and divide quite rapidly. A crop may be harvested within seven to eight weeks in the fall. Some growers continue to use sets for later plantings, while others use green transplants obtained by breaking up the bunches. Pink root symptoms are quite conspicuous on green transplants. For this reason it is an easy matter to eliminate diseased plants before they are set in the field. Pink root is not so easy to detect on the dry sets, making the problem of

getting disease-free planting material more difficult. But if reasonable care is exercised in selecting pink root-free sets or green transplants, the amount of disease can be greatly reduced.

Shallot Set Treatment Tests. In order to reduce the amount of pink root in shallot sets used for seed purposes a series of chemical treatments was started some years ago at the Louisiana Agricultural Experiment Station (18). These tests were carried on for several years. The results from the earliest tests made with disease-free material indicated that the shallot sets as well as the green transplants were quite susceptible to injury from fungicide treatments.

In later tests either dry sets or green transplants naturally infected with pink root were soaked for varying lengths of time in water suspensions or solutions of the chemicals and planted in soil free of the disease. Some tests were conducted in the field and others in the greenhouse in steamed soil. Several well known fungicides were used in these tests, among them Puratized N5E, now known as Puratized Agricultural Spray, mercuric chloride, Semesan, Spergon, Phygon, Ceresan, and Arasan. The results of most of the tests were inconclusive. Usually if the fungicide was used in strength sufficient to reduce the amount of pink root, the plants were injured. The type of injury ranged from delayed growth to severe stunting and outright killing of the bulbs or green plants. In two tests mercuric chloride 1-500 and Semesan 1 lb. - 50 gals. showed some promise, but in other tests these materials were ineffective.

A number of dust treatments were also made. The dry sets were placed in paper bags with the dusting material and agitated thoroughly until the dust was well distributed over the bulbs. The bulbs were planted in pink root-free soil. In general the results of the dust treatments were similar to those obtained with the liquid treatments. One combination liquid dip and dust treatment (Ceresan dip + Arasan dust) gave good results in a single test. A summary of numerous tests indicated that in general the chemical treatments either caused severe injury to shallot planting material (dry sets and green plants) or did not control pink root.

Breeding for Pink Root Resistance. In cooperation with Dr. H. A. Jones, U. S. Department of Agriculture, Beltsville, Maryland, a shallot breeding project was started in 1949. The crosses were made by Dr. Jones in Beltsville and the plants were tested in the field at Baton Rouge. The first lots tested were polyploids, mostly tetraploids, that were the results of crosses between shallot and Nebuka onion (Allium fistulosum) and then the chromosomes doubled. The first year 99 lots with a total of 650 plants were tested. The shallot seedlings were set in a plot (December 1949) that was thoroughly infested with the pink root fungus. They were left in the field until June 1950, when they were pulled and final observations made.

Most of the shallots in the field test were quite large and coarse and divided much more slowly than the common shallot parent. They were all too large and coarse to be used commercially. Most of the plants remained green until they were pulled and very few formed bulbs. There was considerable variation in the reaction of the different lots to pink root. Most of the plants did contract the disease but few showed any above-ground symptoms. However, two of the lots showed very severe pink root infection on the roots.

The following season (1950-51) progenies of the back crosses from the polyploids used in 1949-50 to the common shallot were tested. In this test some 900 plants of 33 lots were tested against pink root in the same plot used the year before. Again the shallot hybrids divided rather slowly as compared with the common shallot and in general had more of the A. fistulosum characters than those of the shallot parent. About one-third of the bunches remained green until the end of the season and never did form bulbs. The others died back more or less as the common shallot does and formed bulbs of varying size and shape. The pink root reaction was determined by dividing the bunches into groups according to the relative number of pink roots. Bunches with mild infection were classed as resistant and those with moderate to severe infection were rated as susceptible. In the entire group of back crosses 42 percent showed resistance and 58 percent were susceptible. However, none of the plants were suitable for commercial use. Second back crosses using the resistant selections have been made to shallot and are again being tested.

The breeding work is being continued in cooperation with Dr. Jones and Dr. A. E. Kehr of the Louisiana Agricultural Experiment Station.

Rotation. Little information is available on the effect of rotation in reducing the amount of pink root in shallots. However, it is a matter of common observation that the disease does build up in most soils, and becomes more severe the more often shallots are grown in them. Most of the shallots in Louisiana are grown on small farms where there is little opportunity for any sort of effective rotation system. Taubenhaus and Mally (13) recommended a rotation that only included onions every three or four years. Such a system would not be practicable on most Louisiana farms, but it is recommended that shallots not be planted in the same fields more often than is absolutely necessary.

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LOUISIANA AGRICULTURAL EXPERIMENT STATION
BATON ROUGE

FALSE BROOMRAPE AND LEAF CURL: TWO NEW TOBACCO DISEASES IN KENTUCKY

W. D. Valleau

FALSE BROOMRAPE: In 1951, John Cochran, county agent, Adair County, Kentucky, found outgrowths on the roots of burley tobacco plants that he took to be broomrape. In 1952 he sent in similar specimens, early in the summer, that we diagnosed as broomrape. Later he reported that the "broomrape" did not get above ground. This summer he brought in a specimen, a few leaves of which had gotten above ground and turned green. The outgrowths were evidently tobacco shoots developing from the roots of the plants. In some instances there was a sufficient mass of these shoots to raise a considerable block of soil at the base of the plant. Mr. Cochran reported eight of ten fields in one section of the county affected, while in another section only two of ten fields were affected. In a one-day examination by the writer and E. M. Johnson we found in some fields that every plant examined had the outgrowths, varying from masses 2 or 3 inches across on the taproot of stunted plants to plants that appeared to have made normal growth but had a few white shoots growing from either large or small roots. The trouble has been reported from Adair, Metcalf, Edmonson, Green, Taylor, Larue, Hardin, Daviess, and Christian Counties. (Fig. 1, Fig. 2)

FIGURE 1. False broomrape, cause undetermined, on burley tobacco in Kentucky. Numerous buds are developing from the taproot and larger roots. The trouble evidently started early in the summer.

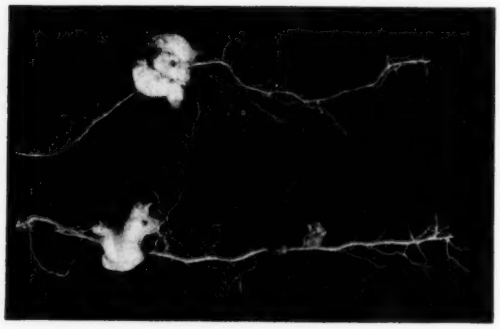

FIGURE 2. White outgrowths from the roots of mature tobacco plant. Sometimes only a few outgrowths such as these are found on the roots, suggesting a late infection.

As to injury caused, it is too early to say. Some small plants with a large mass on the roots seem to have been held back, but equally stunted plants can be found that are free. Some growers whose plants were affected nearly 100 percent had not recognized that anything was wrong. As to varieties, it has been reported on Ky 16, Ky 26, Ky 35, Ky 41A, and Ky 57, and on several varieties of dark tobacco. As to cause nothing is known. At first it was thought it might be the effect of a growth-regulating substance in one of the new chemicals used as a starter solution, an insecticide in setter water, in fertilizer, or as an insecticide on beds or in the field. Its limited distribution to one area of the State, however, would seem to eliminate such a cause. There is a suggestion of spread of a causal agent throughout the summer, because some plants have large masses of shoots, some of which are already decayed, while others have only the beginnings of buds, and others with all intermediate stages. This might indicate

a virus as the causal agent. It has been suggested that mites might be the cause, but the trouble is not typical of the stunting of growing points caused by mites.

FIGURE 3. Leaf curl of burley tobacco in Kentucky.

LEAF CURL: Leaf curl (Fig. 3) identical in appearance with that found in India, according to D. I. Mathrani, who examined specimens sent to the Kentucky Agricultural Experiment Station, has been found in Fayette, Clark, Hart, Christian, Carroll, Franklin, and Ballard Counties. Usually no more than one or two affected plants were found in a field. Dr. Diachun has demonstrated that the disease is graft-transmitted.

KENTUCKY AGRICULTURAL EXPERIMENT STATION, LEXINGTON

THE STYLET NEMATODE, TYLENCHORHYNCHUS DUBIUS, A ROOT PARASITE OF ECONOMIC IMPORTANCE IN THE SOUTHWEST

Harold W. Reynolds and Milton M. Evans[1]

Within the past few years considerable attention has been given to nematodes that puncture and feed on roots from the outside. Christie (1), along with other workers, has demonstrated that these ectoparasitic nematodes constitute pests of major importance in the southeastern United States (3, 5, 7). In 1937 Steiner (6) described Tylenchorhynchus claytoni from the roots of tobacco, Nicotiana tabacum L., hybrids in South Carolina, later terming it the tessellate stylet nematode. At that time he considered this form an apparently rare nemic parasite of the tobacco plant, but he has since concluded that it is quite widely distributed in the eastern states and is a root pest of many species of plants.

In numerous soil sample examinations, the writers have found that Tylenchorhynchus dubius (Bütschli, 1873) Filipjev, 1936, is the most common species of the stylet nematodes associated with the roots of both native and cultivated plants in the Southwest. Accordingly, several experiments have been conducted to determine if this nematode feeds on plant roots and, if so, the extent of the damage.

Experimental Results

The nematodes used for inoculation in the studies were taken from a large pot of soil in which cotton had been grown for 90 days. This soil had previously been pasteurized and inoculated with only the stylet nematodes, T. dubius. This procedure insured the use of inoculum which was virtually free from other contaminating forms. The stylet nematodes were removed from the soil by a combination of sieving and the Baermann technique as described by Christie and Perry (2). The nematodes were drawn from the Baermann funnels in a small quantity of water, and held in the refrigerator at 7° C for later use.

Experiment 1.
Attempts to Culture Stylet Nematodes on a Fungus

In this study an unidentified non-sporulating soil fungus was isolated and cultured in petri dishes on prune agar. When the fungus had grown to approximately 25 mm. in diameter, 20 stylet nematodes were transferred under the dissecting microscope to the margin of the fungus in each of the three dishes. Species of Aphelenchus, Ditylenchus, and Aphelenchoides which had been observed to feed on fungi were also transferred to other petri dishes in which cultures of this same fungus were growing. All cultures were observed daily, under dissecting and compound microscopes, for visible evidence of feeding on the fungus. The stylet nematodes did not feed on the fungus, and after migrating on the agar surface for a short time they burrowed into the agar and remained quiescent. This experiment was repeated but in no instance was evidence of feeding or nematode reproduction observed. The species of Aphelenchus, Ditylenchus, and Aphelenchoides were each observed to feed on the fungus and reproduce readily.

Experiment 2.
Reproduction of the Stylet Nematodes in the Presence of Cotton Roots

Twelve test tubes approximately 25 mm. in diameter were used in this study. Six were filled about two-thirds full with a sandy loam soil and sterilized in the autoclave at 15 pounds pressure for 45 minutes. In three tubes one seed of Hopi M cotton, Gossypium hirsutum L. var. punctatum Shumacker, was planted. The other six tubes were filled two-thirds full with sandy loam field soil but were not sterilized. As with the previous group, only three of these unsterilized tubes were planted with cotton. All twelve tubes were inoculated by transferring 50 living stylet nematodes to each tube. After 60 days the approximate number of living nematodes per tube was determined by means of the Baermann funnel technique, as given in Table 1.

[1]Nematologist and assistant nematologist respectively, U. S. Department of Agriculture, Bureau of Plant Industry, Soils and Agricultural Engineering, Sacaton, Arizona.

Table 1. Total number of stylet nematodes recovered from the test tubes

Treatment	Number of stylet nematodes
Sterilized soil:	
Seeded with cotton	469
Not seeded with cotton	0
Soil not sterilized:	
Seeded with cotton	35
Not seeded with cotton	0

These data show that this nematode will not thrive and reproduce on soil fungi alone. A fair-sized population, however, resulted in tubes in which cotton had been grown, especially in sterilized soil. A few nematodes were observed in the unsterilized tubes of soil in which cotton had grown and it is reasonable to assume that others might have been eliminated by natural enemies such as predaceous nematodes and fungi.

Experiment 3.
The Effect of Stylet Nematodes on the Growth of Hopi M Cotton (Greenhouse Pot Cultures).

Eight 6-inch clay pots of pasteurized soil were embedded in sand in the greenhouse bench. The experiment consisted of four replications and was randomized. Since the experiment was conducted during the winter, a soil temperature of 24° to 27°C was maintained by an electric heating cable embedded beneath the pots.

Inoculations were made by pouring 300 nematodes in a small amount of water into shallow depressions made on the soil surface of four pots. The other four pots were not inoculated and served as controls. Three Hopi M cotton plants were grown in each of the eight pots for a period of 60 days. At that time the cross sectional stem area of each plant was determined by measuring one inch above the crown with a micrometer caliper. Table 2 shows the mean cross sectional stem area of plants of the 12 inoculated and 12 uninoculated pots.

Table 2. Growth of cotton plants in soil inoculated with stylet nematodes and in uninoculated soil (greenhouse test)

Treatment	Cross sectional area of stems; mean of the 4 replications (square millimeters)
Inoculated	8.35
Uninoculated (control)	11.88
L.S.D. at .05 level	2.69

These data show a significant difference in cross sectional area of stems between the inoculated and uninoculated pots. Figure 1 also shows some difference in height of plants. There was, however, more variation in height within plants of the inoculated pots than there was within plants of the uninoculated ones.

FIGURE 1. The 12 plants in the 4 pots on the left were grown in pasteurized soil which was not inoculated. The four pots on the right were inoculated with stylet nematodes.

Experiment 4.
The Effect of Stylet Nematodes on the Growth of Hopi M Cotton (Pot Test in the Open)

This study was similar to experiment 3 except that information was desired on the effect of the nematodes on cotton during the summer months. The experiment was therefore conducted in pots embedded in fallow land outside the greenhouse, and was replicated five times and randomized. The number of nematodes transferred to each of the five inoculated pots was approximately twice the number used in experiment 3. The other five pots were not inoculated and served as controls. Eight-inch clay pots were used in this study and only one plant was grown in each of the ten pots. After 90 days of growth the diameter of the stems was measured one inch above the crown, and the mean cross sectional stem area of the plants for the inoculated and uninoculated pots is given in Table 3.

Table 3. Growth of cotton plants in soil inoculated with stylet nematodes and in uninoculated soil (grown outside greenhouse)

Treatment	Cross sectional area of stems; mean of 5 replications (square millimeters)
Inoculated	53.34
Uninoculated (Control)	118.40
L.S.D. at .05 level	45.34

The cross sectional area of stems was less on plants which grew in the inoculated soil. Figure 2 shows differences between plants growing in inoculated pots and variation between plants which had received the same treatment.

Experiment 5.
The Effect of Stylet Nematodes on the Growth of Tepary Beans

This study was conducted in order to determine if this nematode would attack the roots of a leguminous plant, the tepary bean, Phaseolus acutifolius A. Gray var. latifolius Freeman.

FIGURE 2. The five plants on the left were grown in pasteurized soil which was not inoculated. The five pots on the right were inoculated with stylet nematodes.

The experiment consisted of five replications and was conducted under the same conditions and at the same time as experiment 4. After the plants had grown for 90 days they were excised at the crown, and green weight determinations were made of the vines as shown in Table 4.

Table 4. Effect of stylet nematodes on the growth of tepary beans (grown outside greenhouse)

Treatment	Green weight of vines (Mean of 5 replications) (Grams)
Inoculated	37.16
Uninoculated (control)	52.96
L.S.D., .05 level	13.90

There was a significant decrease in green weight of vines in pots which had been inoculated. The plants which grew in inoculated soil were lighter green in color than those of the uninoculated pots.

Comments and Conclusions

The stylet nematode T. dubius does not appear to be so devastating to the roots of plants as are certain of the other ectoparasites such as the stubby root, awl, and sting nematodes. Nevertheless, moderate stunting of growth has been produced experimentally under both greenhouse and field conditions. Apparently the parasite feeds at the root tips and possibly along the side of young roots, thereby causing a debilitation in which both the top and root systems are reduced in size. The adult nematode has not been observed within the root tissues but six very young larvae were found in secondary roots of cotton plants which had

scarcely pushed through the epidermis. T. claytoni, however, has been found by Steiner (6) in both adult and larval stages distributed through the root parenchyma of tobacco, indicating a vagrant mode of life. Is it possible that members of this genus are capable of feeding both inside and outside roots?

Is it also possible that such nematodes as T. dubius can be the cause of crop debilitation sometimes attributed to other causes? For example, it is well known that very significant increases in crop yields have been achieved by soil fumigation for control of root-knot nematodes (Meloidogyne spp.), which are endoparasitic and sedentary in habit. On the other hand, increased crop yields have also been reported after fumigation of land judged to be free of root-knot nematodes. An increase of available nitrogen was thought to be responsible for this growth "stimulation". Kincaid and Volk (4) believed that nitrogen transformation in the soil is affected by fumigation, whereby the change of nitrogen from the ammonia form to the nitrate form is delayed for several weeks, extending into the growing season in the field. They believe that this delay has the effect of conserving nitrogen ordinarily lost as nitrate by leaching during the early part of the season. Information obtained in the present experiments with the stylet nematodes would suggest that the control of these nematodes and possibly other ectoparasitic nematodes through soil fumigation would account for much of this increase in growth rather than a nitrogen transformation in the soil.

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U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING
SACATON, ARIZONA

A NEMATODE ASSOCIATED WITH A ROOT ROT OF SCINDAPSUS[1]

W. G. Kemp[2]

A destructive root rot of the variegated ivy was observed in a florist's greenhouse at London, Ontario in April, 1953. This plant, Scindapsus aureus, formerly known as Pothos aureus, is grown extensively for its foliage. Conspicuous foliage symptoms varying in severity were present on 60 percent of some 2,000 potted plants (Fig. 1). These plants had been imported into Canada as rooted cuttings from propagators in Florida.

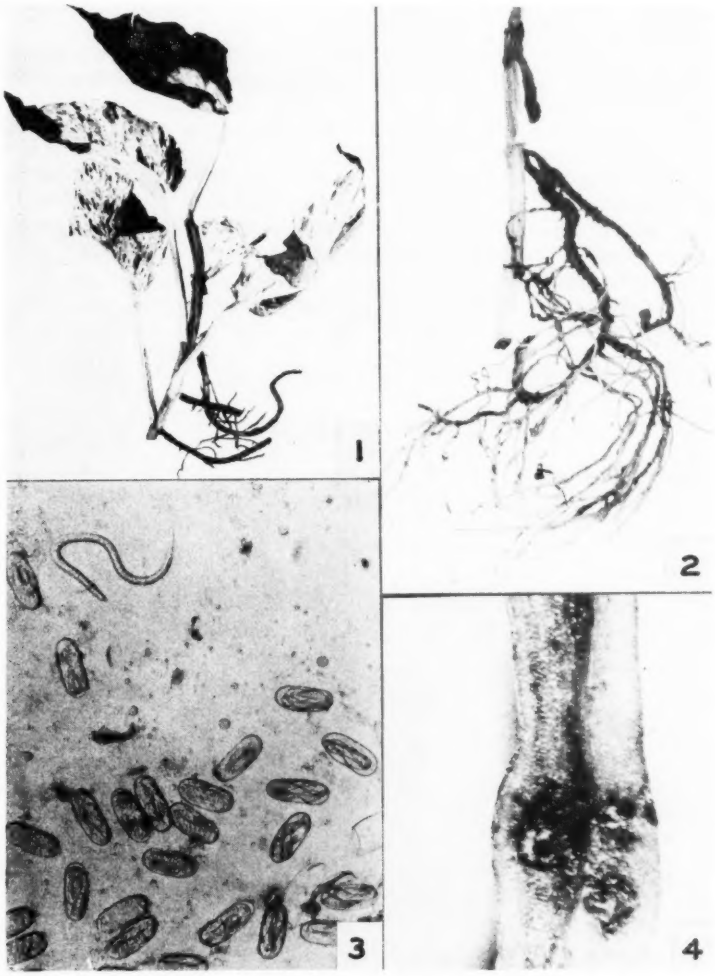

FIGURE 1-4. 1. Severe root deterioration and foliar necrosis of a variegated ivy plant due to root-knot nematode. 2. Roots of an infested specimen showing minute galls on the tips of the more tender rootlets. 3. Eggs in various stages of development and a young root-knot larva from a gall (x about 75). 4. Longitudinal section through a larger root showing necrotic cavities which contain various forms of the nematode.

[1]Contribution No. 1325 from the Botany and Plant Pathology Division, Science Service, Department of Agriculture, Ottawa, Canada.

[2]Associate Plant Pathologist, Plant Pathology Laboratory, St. Catharines, Ontario.

Washed roots of plants which were not extensively damaged showed minute galls on many of the more tender rootlets, either at the tips or at intervals along them (Fig. 2). When broken open and examined microscopically, these galls revealed nematode eggs in various stages of development, larvae, and mature females (Fig. 3). In the larger roots there was little or no swelling visible, but longitudinal sections of many of these roots revealed cavities containing nematodes (Fig. 4). The cavities were usually found in the parenchymatous tissue of the root cortex adjacent to the stelar region. In many areas of the root, the cortex was completely invaded and killed, finally sluffing off to leave the stele exposed. The aerial cord-like roots which are produced at the leaf nodes and which frequently become established in the soil, were infested and later invaded by fungi that caused stem lesions. Several fungi have been isolated from tissues affected by this nematode and their role in the symptom expression is under investigation.

Foliar symptoms appear as a result of the defective root system. The leaves become necrotic at their margins and later shrivel and die. Young shoots have been observed to collapse suddenly. Badly infected plants are often killed.

Infected root specimens of Scindapsus aureus were submitted to Dr. A. D. Baker, Officer-in-Charge, Nematode Investigation Unit, Entomology Division, Ottawa, who kindly identified this parasite as a species of the root-knot nematode belonging to the genus Meloidogyne.

This appears to be the first record of the root-knot nematode attacking variegated ivy in Canada. Circumstantial evidence supports the hypothesis that the nematode infestation of Scindapsus at London, Ontario could be attributed to rooted cuttings infested with the endoparasite which had been imported from Florida.

PLANT PATHOLOGY LABORATORY, ST. CATHARINES, ONTARIO, CANADA

GRASSY-TOP SYMPTOMS IN GLADIOLUS REPRODUCED BY EXPERIMENTAL INOCULATION WITH WESTERN ASTER YELLOWS VIRUS

By Floyd F. Smith[1] and Philip Brierley[2]

In an earlier report (2) we described, with R. O. Magie, the grassy-top disease of gladiolus and the recovery of the western aster yellows virus from naturally infected plants. Inoculation of gladiolus in early stages of growth with this virus failed to reproduce the grassy-top symptoms; we suggested that infection in later stages of growth might give rise to grassy-top in the second season. We now report successful reproduction of the symptoms with this virus, together with records of the symptoms produced in gladiolus inoculated at different stages of development, and also experimental production of yellows symptoms in dahlia.

A series of 26 inoculations were made with the western aster yellows virus by means of the vector, the six-spotted leafhopper, Macrosteles fascifrons (Stål) (= M. divisus (Uhl.)), during the period March 1952 to March 1953. This virus was twice recovered from grassy-top gladiolus, and was maintained in China aster or celery. Picardy gladiolus was inoculated at various times from April to November 1952, and dahlia, zinnia, and carnation were included when available. During the exceptionally hot weather of July and early August 1952 many inoculations failed, presumably because of partial inactivation of the virus in the leafhoppers or the source plant, or in both. The western strain of the virus was successfully maintained through this heat period in China aster, however. Attempts to compare our stock eastern strain from chrysanthemum, variety Igloo, with the western strain from gladiolus were generally unsuccessful. The eastern strain appeared to be more sensitive to heat and failed to infect during the summer months, but was transmitted from Igloo chrysanthemum to China aster in January 1953. Ten of the most successful tests are summarized in Table 1.

Symptoms in Gladiolus

Picardy gladiolus inoculated in April when 8 to 10 inches tall made no further growth, but died down with symptoms resembling those caused by Fusarium infection (2). The yellowing and drying following infection with aster yellows tend to develop first in the upper part of the leaf above the site of infection. Yellowing associated with Fusarium rot is usually general over the entire leaf

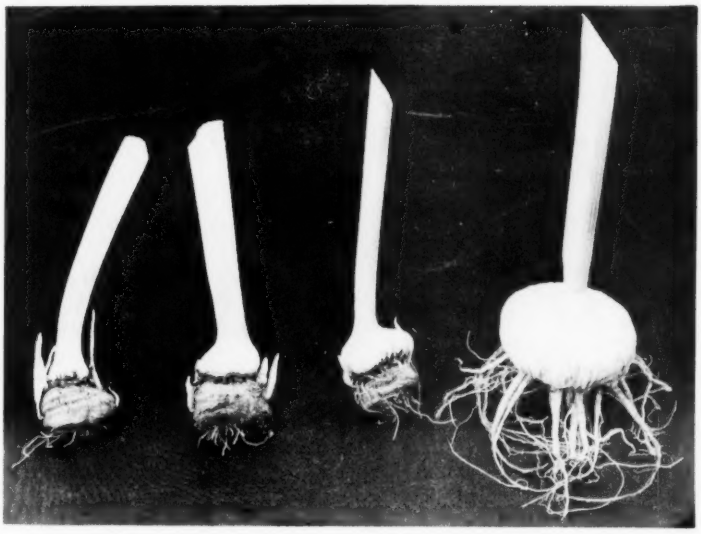

FIGURE 1. Picardy gladiolus inoculated July 6 to August 19, 1952, with western aster yellows virus from China aster (No. 18-47). Three infected plants at left and one escape (corm 6 cm. diam.) at right. Note arrested development of new corms, absence of contractile roots, and proliferation of weak shoots from lateral buds of old corms in infected plants.

Photo by Greeson, October 29, 1952.

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Table 1. Results of inoculations with western aster yellows virus by means of the vector Macrosteles fascifrons.

Test no.	Date	Source plant	Number of test plants infected out of number inoculated						Symptoms in gladiolus
			Aster	Celery	Dahlia	Zinnia	Carnation	Gladiolus	
	1952								
18-36	Mar. 20	Gladiolus	5/10	-	-	-	-	-	-
18-37	Apr. 20	Aster	-	-	-	1/6	-	4/5	Early death
18-38	May 9	Aster	-	4/5	4/10	-	-	-	-
18-48	July 28	Celery	5/6	3/7	0/5	-	0/4	0/4	-
18-51	Aug. 15	Aster	-	8/10	-	-	0/10	0/3	-
18-47	July 6-Aug. 19	Aster	-	-	-	-	-	17/20	Early maturity, new corms not viable
18-59	Sept. 26-Nov. 20	Celery	9/12	3/5	0/5	0/20	0/11	10/18	Normal first year, grassy-top second year.
18-56	Oct. 27	Gladiolus	5/10	0/5	-	-	-	0/3	-
	1953								
18-61	Jan. 8	Celery	3/3	-	2/5	-	-	-	-
18-64	Mar. 31	Aster	10/10	0/6	0/2	-	0/1	-	-
Total			37/51	18/38	6/27	1/26	0/26	31/53	

surface, but the effects of the two diseases are not always recognizably different. As the tops die from aster yellows, the corms also die and shrivel; they may or may not decay.

In one test (No. 18-47) 20 Picardy plants were inoculated at four stages of growth from 6 inches tall to a stage with three or four fully expanded leaves. Three plants showed thin, weak spikes with small green flowers five weeks later. Fourteen other plants matured early and dried down, although escapes remained green. At harvest the three escapes had new corms 4.5 to 6 cm. in diameter with normal contractile roots, and the 17 infected plants showed arrested development of new corms 1.5 to 3.5 cm. in diameter, or no new corms. Six of the infected plants produced thin, weak shoots from lateral buds of the old corms (Fig. 1). Five plants in this series inoculated on August 14 to 19, when they had three or four mature leaves, produced new corms 2.5 to 3.5 cm. in diameter, which were nearly normal but failed to break cleanly from the parent corms and thus showed rough corky bases. Eleven corms were replanted in 1953, but only the three escapes emerged. Thus in our trials Picardy plants infected before flowering stage failed to survive in the second season.

In another test (No. 18-59) 18 Picardy plants were inoculated at the flowering stage or later (Table 2). Some of those inoculated at the flowering stage showed early maturity, small

Table 2. Results of inoculation (No. 18-59) of Picardy gladiolus at flowering stage or later with western aster yellows virus from celery.

Date inoculated 1952	Number of plants inoculated	Stage of development of gladiolus	Current-season effects			Symptoms in second season (1953)
			Plant reaction	At harvest December 8	At cleaning December 17	
Oct. 16-27	8	Full flower. Oct. 16; flowers dried Oct. 27	7 plants matured early	New corms small; few cormels; contractile roots few to several, arrested in growth; roots few	Irregular separation from old corm, rough basal scars	5 rotted, 3 grassy-top.
Nov. 11-14	5	Flower stalks yellowed to top-leaf sheath	3 plants yellowed early	New corms normal size; many cormels, not fully mature; many contractile roots, fully developed	Clean separation, normal basal scars	1 escape, 4 grassy-top.
Nov. 11-14	5	Same as above but non-flowering	Normal	New corms normal size; many cormels, some mature; many contractile roots, fully developed	Clean separation, normal basal scars	2 escapes, 3 grassy-top.

corms, and low viability, as in the previous experiment. Those inoculated after flowers were past appeared normal for the remainder of the season and also at harvest and at cleaning time. All three series developed some typical grassy-top in 1953 (Figs. 2, 3). No surface abnormalities were noted when these corms were planted in 1953. However, when normal plants were in flower, corms of infected plants had many weak etiolated shoots in addition to those appearing above the soil line. Further swelling of buds suggested that still further shoot production was in progress. At this time some root bases were rough and corky, although as indicated previously, this condition was not noted at planting time. Additional characters included a large number of fine feeding roots, many of which were apparently dead, and no contractile roots or cormels. The core area of the diseased corms was large and the storage tissue paler, as was noted in naturally infected corms (2), but discolored root traces were not evident in experimentally infected corms.

This experiment shows that grassy-top in gladiolus can be produced by western aster yellows virus infection after flowering, and that infected plants express no reliable evidence of such infection until the next season of growth. Our data indicate that infection at full flowering stage or earlier will lead to current-season symptoms such as early maturity, small corms, and arrested development of contractile roots.

FIGURE 2 (above). Grassy-top symptoms developing in 1953 from inoculation in 1952 with western aster yellows virus from celery (No. 18-59). Normal escape plant at right; all in 5-inch pots. Photo by Greeson, July 10, 1953

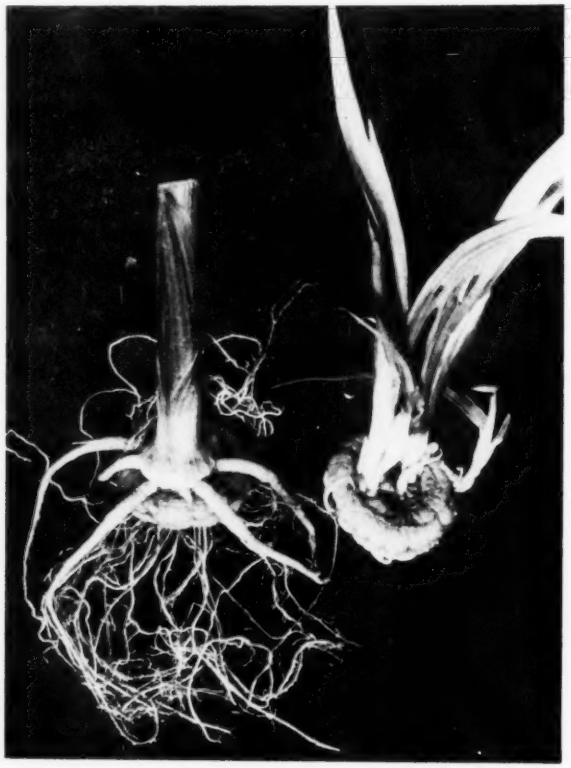

FIGURE 3 (right). Grassy-top symptoms in 1953 in Picardy gladiolus corm at right artificially infected on November 4, 1952. Note excessive sprouting and bud swelling and lack of contractile roots or of current season corms on the infected old corm (right). Normal corm and shoot at left. Photo by Greeson, August 20, 1953

Aster Yellows in Dahlia

Dahlias have been regarded as insusceptible to aster yellows since Kunkel (1) failed to infect them experimentally. An apparent outbreak of aster yellows in Jersey Beauty dahlias near Baltimore, Maryland was brought to our attention in September 1947. Affected plants showed shortening of internodes of the main shoots so that commercial cut flowers were not

available. Young leaves showed yellowing of the margins resembling hopperburn; flowers were small, pale, and often one-sided, but never green or proliferated; lateral shoots were somewhat more numerous than usual. About 90 percent of the plants on nine acres showed this condition. Plants had been sprayed for Japanese beetle control every three days through August, but aster leafhoppers were abundant in September. A planting of China asters was a total loss from yellows, and the disease was evident in Erigeron sp. and Lactuca sp. growing nearby as weeds. Attempts to transmit the virus from affected dahlias failed, and sample plants collected did not survive storage until the following spring.

In May 1952 five Jersey Beauty and five Unwin's hybrid dahlias were inoculated with western aster yellows virus from China aster. Two plants of each group expressed shortening of internodes and small yellowish leaves in one or more shoots. The virus was returned to China aster from Unwin's hybrid but not from Jersey Beauty. The Unwin's hybrid from which the virus was reisolated survived several months, but withered and died in the fall. Aster yellows appears to be self-eliminating in this dahlia variety just as in several varieties of chrysanthemum.

In a second experiment in January 1953, two of five Unwin's hybrids inoculated with western aster yellows virus from celery developed similar symptoms; recovery of the virus was not attempted.

Efforts to infect dahlia with the eastern aster yellows virus in several series of tests since 1947 have uniformly failed, but it is by no means certain that dahlias are insusceptible to the eastern strain, which was inconsistent in performance during this series of tests. In August 1952 we collected an Unwin's hybrid dahlia at State College, Pennsylvania, showing symptoms comparable with those experimentally produced with western aster yellows virus, but attempts to transfer a virus from this plant to celery failed.

Aster Yellows in Zinnia and Carnation

Zinnia, like celery, is susceptible to the western but not to the eastern strain of aster yellows virus. In our experiment (Table 1) zinnia proved more difficult to infect than China aster or celery. Since infection of celery failed in two tests, no significance is claimed for low infection of zinnia. Natural infection of zinnia with aster yellows is reported from Michigan and Pennsylvania by the Plant Disease Survey. One affected zinnia from nearby Maryland was brought to our attention in 1951. Sporadic appearance of aster yellows in zinnia in the East indicates that the western strain has been introduced occasionally. The western strain might be expected to persist in the same hosts that harbor the eastern strain, but there is no evidence thus far that western aster yellows virus is established eastward.

Thomas (3) and Thomas and Daniels (4), reported that the aster yellows virus in Colorado, presumably the western strain, produces the streak disease, and also malformation of flowers, in carnation. As shown in Table 1, carnation plants were exposed to infection with western aster yellows virus in four tests in which China asters, celery, or both were successfully infected. None of 26 carnations exposed developed streak or other symptoms, although they were held until the following May. Thus our experiments failed to confirm the aster yellows virus as the cause of carnation streak.

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BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE, AND BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, AGRICULTURAL RESEARCH ADMINISTRATION, U. S. DEPARTMENT OF AGRICULTURE, BELTSVILLE, MARYLAND.

ORNAMENTAL FLOWERING PLANTS NATURALLY INFECTED WITH THE CURLY-TOP VIRUS IN SOUTHERN NEW MEXICO[1]

Philip J. Leyendecker

In the last decade, the curly-top virus, Ruga verrucosans Carsner & Bennett, has been responsible for appreciable crop losses in southern New Mexico. Climatic conditions and the abundance of susceptible native and weed flora (4, 5, 12) afford ideal biological factors for the production of large viruliferous populations of the vector Circulifer tenellus Baker. (2, 10, 11). For this reason, the U. S. Department of Agriculture has maintained a sugar-beet testing program for curly-top resistance at New Mexico A & M College even though the crop is no longer grown commercially in New Mexico.

For a number of years, home gardeners in southern New Mexico have complained of their inability to grow certain annual and perennial ornamental flowering plants. In most instances, the trouble has been traced to the curly-top virus. Symptomatology has checked closely with the descriptions by Severin and Freitag (3, 6, 7, 8). Additional information concerning the susceptibility and resistance of the newer varieties of ornamentals grown in the area to the curly-top virus would be of material benefit to home gardeners.

An opportunity to check the reaction of 33 ornamental flowering plants (1) in 11 different families was afforded in 1952. An extensive randomized planting was made by a home gardener at State College.[2] Approximately four dozen plants of each variety were taken from cold frames and transplanted to the field in early March, 1953. The entire planting was made on a newly-cleared plot of land completely surrounded by Atriplex canescens (Pursh) Nutt., a native curly-top susceptible host plant. In addition, a very mild winter during 1952-53 resulted in an extremely high population of the beet leafhopper and afforded ideal conditions for disease transmission. No attempt was made by the grower to control the population of beet leafhoppers after transplanting.

Final disease notes were taken on May 20, 1953, when most of the susceptible entries had succumbed to the disease. Many of the highly susceptible species had completely disappeared three to four weeks prior to the final disease evaluation. Table 1 shows the final curly top evaluation of the 33 entries. Typical curly-top symptoms such as dwarfing, vein clearing followed by chlorosis, and death were observed.

Only eight of 33 flowering ornamentals, in six different families, did not show visible symp- of the curly-top virus. Seven species were perennials, and one was an annual. The remaining 25 species, six biennials and 19 perennials, showed definite symptoms of curly-top. Of this number, 13 were highly susceptible and succumbed to the disease early in the season. Six different families were represented in this group. The remaining 12 species, in seven families, constituted an intermediate group which exhibited varying degrees of disease expression and could possibly be recommended for planting during years when the beet leafhopper populations are low. Otherwise, only eight species tested, seven perennials and one annual, can be recommended for planting in southern New Mexico.

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[1]Contribution No. 84 from the New Mexico Agricultural Experiment Station. Department of Biology.

[2]Dr. Sigurd A. Johansen.

Table 1. Reaction of ornamental flowering plants to the curly-top virus, Ruga verrucosans, under natural conditions of infection in southern New Mexico (1953).

FAMILY Scientific Name	Name of Plant: Common	Variety	Seasons Duration	Curly Top Reaction[a]
CAMPANULACEAE				
Campanula calycanthema	Cup and Saucer	Light Blue	Biennial	**
		Dark Blue	Biennial	**
		Rose	Biennial	**
		White	Biennial	**
Campanula medium	Canterbury Bells	Double	Biennial	**
Campanula persicifolia	Peach Bell	Blue	Perennial	**
		Alba	Perennial	**
CARYOPHYLLACEAE				
Dianthus latifolius	Button Pink	Scarlet	Perennial	**
Dianthus plumarius	Cottage Pink	Double Mixed	Perennial	*
		Spring Beauty	Perennial	*
Gypsophila paniculata	Babysbreath	Double	Perennial	0
		Single	Perennial	0
Lychnis chalcedonica	Maltese Cross		Perennial	**
COMPOSITAE				
Chrysanthemum maximum	Shasta Daisy	Alaska	Perennial	*
		Double	Perennial	**
Chrysanthemum parthenium	Feverfew	Snowball	Annual	0
Gaillardia aristata	Blanket Flower	Portala	Perennial	0
Pyrethrum roseum	Painted Daisy	Double	Perennial	*
		Single	Perennial	*
CRUCIFERAE				
Alyssum saxatile	Goldentuft	Compactum	Perennial	*
Iberis sempervirens	Edging Candytuft		Perennial	*
DIPSACEAE				
Scabiosa caucasica	Mourning Bride	House's Giant	Perennial	0
LILIACEAE				
Kniphofia uvaria	Poker Plant		Perennial	0
LINACEAE				
Linum perenne	Flax	Blue	Perennial	*
PAPAVERACEAE				
Papaver orientale	Oriental Poppy	Choicest Mixed	Perennial	**
PLUMBAGINACEAE				
Statice latifolia	Sea Lavender		Perennial	0
RANUNCULACEAE				
Aquilegia sp.	Columbine	Burpee's Best	Perennial	*
		Improved Elliot	Perennial	*
		Mrs. Scott Elliot	Perennial	*
	Larkspur	Pacific Giants	Perennial	**
SCROPHULARIACEAE				
Digitalis purpurea	Foxglove	Shirley Mixed	Biennial	**
Penstemon barbatus	Beard Tongue		Perennial	0
Veronica spicata	Speedwell		Perennial	*

a. 0 Resistant
* Susceptible
**Highly susceptible

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DEPARTMENT OF BIOLOGY, NEW MEXICO, AGRICULTURAL EXPERIMENT STATION

GRAFT TRANSMISSION OF LILAC WITCHES'-BROOM VIRUS

Paul Lorentz and Philip Brierley

A witches'-broom of Japanese lilac, Syringa japonica Decne., was described from Takoma Park, Maryland, in 1951[1]. The disease has been maintained in cuttings from the original diseased plant. Attempts to transmit a virus from this material to the common lilac, S. vulgaris L., and to privets, Ligustrum spp., are reported here.

Three plants of common lilac were inarched to witches'-broom affected Japanese lilac in in October 1951. No union was effected in one case, and the stock remained normal through October 1953. Unions were successful in the other two cases and the Japanese lilac scions were cut free from their roots. Both common lilac stocks developed vein clearing after one month's contact, and after three months to one year, both expressed witches'-broom symptoms as proliferation of thin lateral shoots with small leaves. In common lilac the brooming effect was less striking than in the Japanese lilac source, with fewer shoots proliferated and less reduction in size of leaves. The brooming virus extended slowly through the potted common lilacs, with symptom expression restricted to the branch in contact with the diseased scion after two years. At the end of two years' contact one common lilac stock developed extensive yellowish vein clearing in second shoot, apparently an early symptom of invasion by the brooming virus.

Three species of privet were inarched to Japanese lilac affected with witches'-broom. In the California privet, Ligustrum ovalifolium Hassk., three attempts failed to establish a union, and the privet stock remained unaffected by scion contact after 22 months.

In May 1952, two successful unions of the glossy privet, Ligustrum lucidum Ait., with witches'-broom-affected Japanese lilac were effected. The diseased scions made extensive growth in each, but no symptoms developed in the privet stocks through October 1953. In August 1952, a scion from one of these symptomless privets was grafted on common lilac to determine whether L. lucidum is immune from or a carrier of the witches'-broom virus. Both privet scion and lilac stock remained symptomless through October 1953.

The Regel privet, Ligustrum obtusifolium var. regelianum (Koehne) Rehd., was grafted to witches'-broom-affected Japanese lilac in July 1953. Six weeks later vein clearing appeared in the young leaves of the privet shoot in contact with the witches'-broom scion. The vein-clearing symptom is similar to the initial response of common lilac to the witches'-broom virus. After three months a few thin lateral shoots developed in the axils of the leaves that showed vein-clearing.

Thus the witches'-broom virus of Japanese lilac has been found infectious to common lilac and apparently also to Regel privet. Because the source Japanese lilac grew for years in Takoma Park with no evidence of virus spread to other plants, it seems unlikely that an effective vector is present in this area. Although damaging to the common lilac, the virus cannot be considered a threat to lilacs unless such a vector appears.

DIVISION OF ORNAMENTAL PLANT CROPS AND DISEASES, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

[1]Brierley, Philip. A witches'-broom of lilac. Plant Dis. Reptr. 35:556. 1951.

BOTRYTIS POLYBLASTIS ON NARCISSUS IN THE PACIFIC NORTHWEST

Charles F. Doucette[1]

The prevalence of a rare foliage disease on narcissus during the spring of 1953 in the laboratory plots at Sumner, Washington, offered an opportunity for observation on its behavior. In mid-May diseased foliage was first observed on the narcissus variety Thalia in a replicated experiment designed to test the efficacy of various formulations of heptachlor used as preplanting applications for protection of the bulbs against the narcissus bulb fly (Lampetia equestris (F.)). As the disease progressed in this block and spread to adjacent varieties, it was observed that, in the plots planted to bulbs that had been soaked in either a wettable-powder suspension or an emulsion, infection was distinctly later than in the remainder of the block. These plots were conspicuous because the leaves remained green about two weeks longer than those in the dusted plots and in the untreated checks. This effect was probably due to the inclusion of the fungicide phenyl mercuric acetate in the suspensions and emulsions.

Positive diagnosis of the disease as due to Botrytis polyblastis Dowson was made by C. J. Gould, plant pathologist at the Western Washington Experiment Station, and collaborator with the Division of Ornamental-Plant Crops and Diseases of the Bureau of Plant Industry, Soils, and Agricultural Engineering.

Infection was general throughout the laboratory plots, and the behavior of the disease gave an opportunity to classify the varieties roughly according to their susceptibility. Based on the degree of premature dying of the foliage, the varieties were grouped as follows:

Highly susceptible:
February Gold, Beersheba, Engleheart, Magnificence, Great Warley, Thalia.

Moderately susceptible:
Glorious, Grand Primo, Grand Monarch, Abundance, Dick Wellband

Slightly susceptible:
Actea, Cheerfulness, Emperor, Aerolite, Mrs. R. O. Backhouse, Indian Chief, Bath's Flame, Tampa, Gold Eagle, Mrs. E. H. Krelage, Twink, Spring Glory.

Moderately resistant:
Tunis, Carlton, Sir Francis Drake, Golden Harvest, Silver Star, Texas, Red Shadow, Early Perfection, Olympia, John Evelyn, Fortune, The First, Van Waveren's Giant, Helios, Minister Talma.

Highly resistant:
Rembrandt, Francisca Drake, Nursemaid, Scarlet Leader, Red Cross, White Queen, Golden Sceptre, King Alfred.

The foliage of those varieties rated as highly susceptible was almost completely dead by the first week of June. In contrast, King Alfred plants that were scattered through the planting were definitely resistant.

The occurrence of Botrytis polyblastis in 1953 is of special interest as it is the first general appearance of the disease since 1934 (1), when it was epidemic over the entire Puyallup Valley. Since that time most of the commerical narcissus-bulb growers have persistently used bordeaux mixture as a foliage spray. However, fungicides have rarely been used in the laboratory plots at Sumner. Consequently, these plots have served as an index of the absence of this disease in the intervening period. In general, there was no appreciable amount of

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infection in commercial narcissus plantings in Washignton this season, although small groups of infected plants were observed in a few of these plantings late in the season.

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TOPPLE DISEASE OF DUTCH IRIS

Frank A. Haasis[1]

A previously unreported topple disease in the Wedgewood variety of Dutch iris has been observed on two occasions. The first of these was at Babylon, Long Island, New York in December 1942 where approximately 30 percent of 50,000 Wedgewood plants, growing in flats, were affected with topple. The occurrence of the disorder was quite random throughout the planting. The second observation was made at Castle Hayne, North Carolina in November 1952 where, in a limited greenhouse planting, 14 percent of the plants, in flats, were affected with the topple disease. Thus far, the disease has been observed only under greenhouse conditions of forcing during the short days of early winter.

FIGURE 1. Topple of Wedgewood iris in situ.

FIGURE 2. Topple symptoms in Wedgewood iris: A, normal flower; B, partial collapse of stem and abnormal expansion of floral parts; C and D, collapse of stems and toppling of buds. Enveloping foliage manually displaced.

Symptoms exhibited at these two locations leave no doubt that the same disorder was involved. These were typified by, first, a water-soaking of tissues in the last internode of the flower stem. In many instances but not all, this was followed by an exudation through the epidermis of a viscous liquid which formed in small droplets. Shortly thereafter, there was a shrinking of the affected tissue and finally a toppling of the flower (Figure 1, 2). After the on-set of incipient symptoms, affected stems never produced a normal, fully expanded flower (Figure 2 a). Occasionally floral parts were partially expanded (Figure 2 b). In the majority of cases, however, floral expansion was halted in the bud stage (Figure 2 b, c). The elapsed time for symptom sequence was a matter of only a few hours.

Tissue plating from incipient lesions on potato-dextrose-agar medium yielded no growth, whereas platings from tissues in a more advanced stage frequently yielded Penicillium sp. judged to be a secondary saprophyte.

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Comparisons of bulbs, root systems, and foliage of affected and unaffected plants revealed no obvious differences. Hence, this disorder is not to be confused with the type of toppling that sometimes accompanies crown rot infection caused by Sclerotium rolfsii Sacc. and pictured by Gould (2).

The symptoms of topple in Wedgewood iris and those of the topple disease of tulips (1) are strikingly similar. The similarity of the disease in iris with topple of gladiolus (3), on the other hand, is not so marked. There is, of course, an implicit relationship of topple in tulip and gladiolus owing to the reports that treatments with calcium nitrate minimizes toppling in these two crops. The sporadic occurrence of topple in iris has, thus far, precluded appropriate tests involving calcium nitrate. Hence, a tacit conclusion relative to the causal relationship of the topple disease in these three floral crops is unwarranted.

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LARGE LEAF SPOT AND CANKER OF PEACH CAUSED BY THE FUNGUS FUSICOCCUM AMYGDALI DELACR.[1]

Emil F. Guba

Peach canker was reported in 1941 for the first time in the United States by Haenseler and Daines (5). It had been present in New Jersey for several years previously. The fungus was reported to be morphologically similar to Fusicoccum amygdali Delacr. Boyd (2) found peach canker in the spring of 1940 in southeastern Massachusetts. Now the disease is prevalent in peach orchards in the North Atlantic Coastal Area.

The pathogen was originally described on almond (Prunus amygdalus Batsch) in 1905 by Delacroix (3) from the region of Lake Berr (Etâng de Bèrje), Mouths of the Rhone River, France. Specimens on almond from the Department of Drome, Rhone River Valley, were compared with our specimens on peach and they agreed both as to symptoms of the disease and morphology of the fungus.

FIGURE 1. Infections at nodes occurring early in the growing season. Specimens collected July 15, 1953.

[1]Contribution No. 919 from the Massachusetts Agricultural Experiment Station.

FIGURE 2. The canker fungus progresses rapidly, killing the current and previous seasons' growth with attendant loss of fruit. Specimens collected July 15, 1953.

The disease is destructive to certain varieties of peach, notably June Elberta, Belle of Georgia, Summercrest, Raritan Rose, Eclipse, Cumberland, Golden Jubilee, Jerseyland, and Greensboro. Guba (4) recently has published an encouraging report on its control.

The fungus is infectious to leaves and twigs. Attempts to infect fruit have not been successful.

The large brown spots in the leaves are irregular or circular in outline and often zonate. (Figure 4 A). The centers are sparsely dotted with black pycnidia (Figure 4 B). The spots tear along the margins; then in part fall out of the leaves.

The previous season's wood is infected at the buds of the current season's growth, between the delayed dormant and petal fall periods of tree development. Subsequent infections occur at the nodes or leaf axils of the current season's shoots. Axillary infection occurs throughout the growing season. Only the current season's growth is susceptible to infection by conidiospores.

Arnaud (1) stated that the nodes are infected through wounds, in particular through leaf scars. He reported that pycnidia develop in the autumn and that nodal infections occur the following spring. In Massachusetts serious infections take place in September and October at the nodes through the scales of the axillary buds and at the leaf scars. The cankers appear soon thereafter or in the following spring when growth begins.

The buds are killed before any growth takes place, or the shoots from these buds may grow to a considerable length and then die during the season as the bases of the shoots are girdled by the disease. The shoots may even survive the first season and succumb in the following seasons. As the cankers appear around the nodes along the length of the new shoots, girdling follows and sooner or later the distal portion of the shoot weakens or dies. The shoots are attacked by secondary pathogens, notably by Cytospora, the imperfect form of Valsa

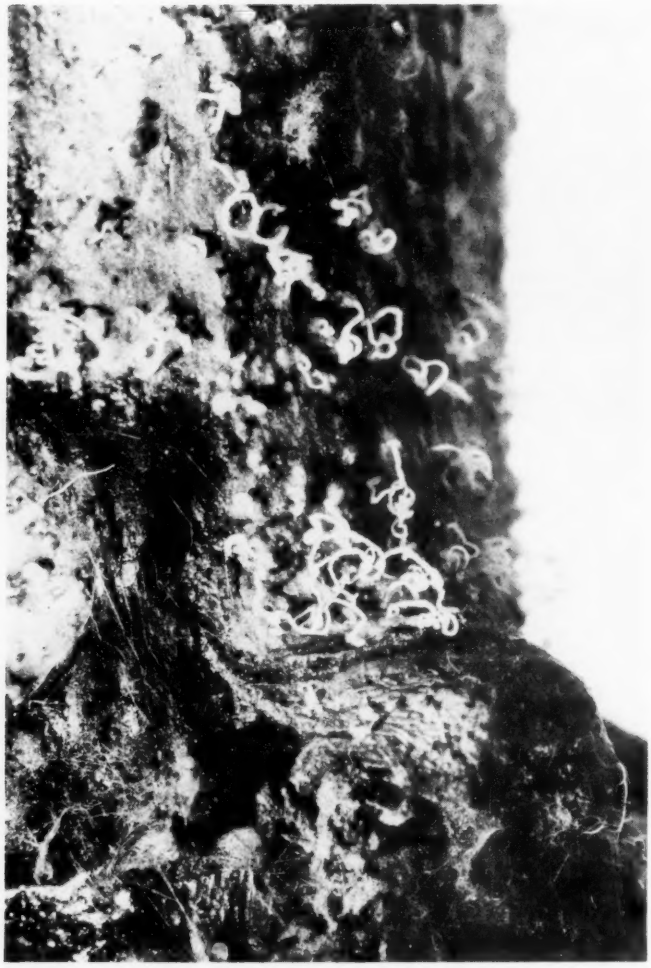

FIGURE 3.
Canker after brief incubation period in moist chamber showing long tendrils of spore inoculum. Identical phenomena occur in rain periods in the orchard.

leucostoma Pers. ex Fr. Diseased trees during the growing season showed a ragged, unhealthy appearance. (Figure 1, 2).

Gummosis is a characteristic feature of the peach canker disease. Pycnidia appear simultaneously with leaf and twig lesions and provide a succession of spore inoculum throughout the growing season. The spores issue from the pycnidia usually in single, dull white cirrhi of considerable length (Figure 3). If the pycnidium is bi- or tri-loculate the number of cirrhi is two or three.

The Fusicoccum fungus winters over in the cankers and apparently in infected leaves. It can be assumed that the perfect stage of the fungus may appear in overwintered infected leaves in early spring. We have been unable to find it in infected wood, in twigs, or in artificial culture.

There is no evidence that the cankers about the shoot buds and the leaf axils on the new growth arise from infected leaf petioles. Invasion of the petiole is secondary, after the appearance of the canker, rather than primary or earlier. Injury is not necessary for infection.

Successful control of the disease is being obtained in southeastern Massachusetts. These orchards, formerly on the verge of being abandoned on account of canker, are being rehabilitated by through-season fungicidal protection beginning with lime sulfur at delayed

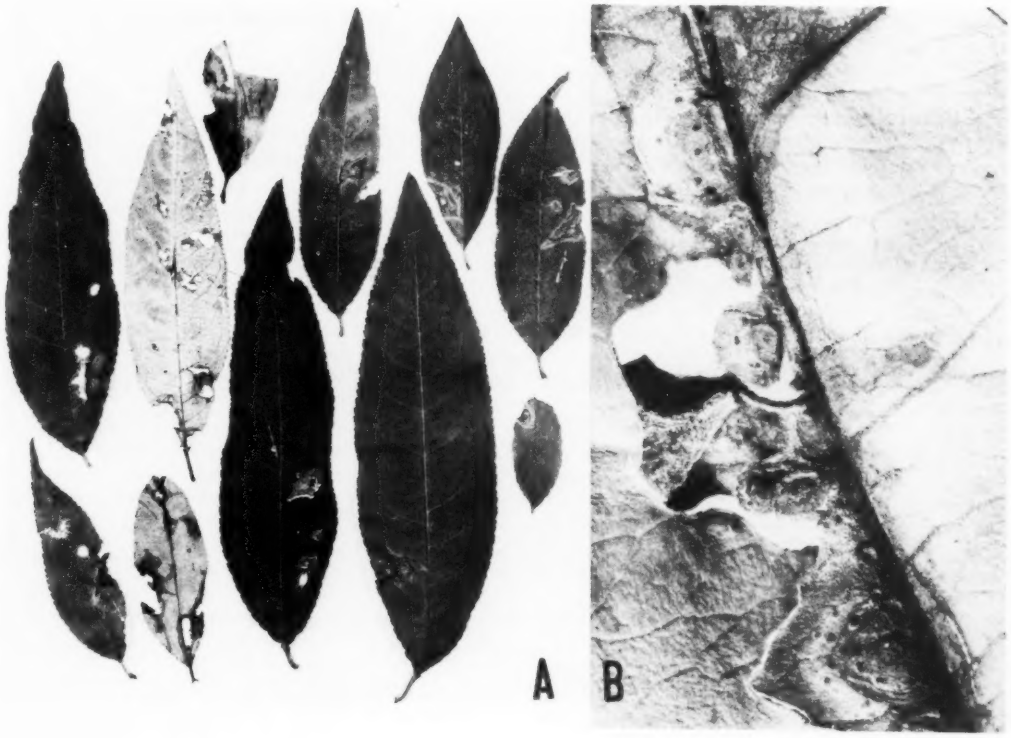

FIGURE 4. A. Typical leaf spots in peach foliage following artificial inoculation of varieties Cumberland and Golden Jubilee on July 14 with spores of Fusicoccum amygdali Delacr. B. Enlargement showing pycnidia.

dormant. Thiocarbamate fungicides, captan, Phygon, Thiram, and lime sulfur are toxic to Fusicoccum conidia. Wettable sulfur is not. Our program has been ferbam or combined ferbam and Phygon with or without some wettable sulfur up until early July on early varieties; then, to avoid objectionable residue on the fruit, captan alone or with some wettable sulfur thereafter.

Protection of the trees with fungicide up to the middle of October is necessary. Up to this time spore inoculum continues to issue from pycnidia in the cankers and leaves.

Removal of diseased branches in the dormant season and a second follow-up or clean-up pruning in May and June are important sanitary features of the rehabilitation program. Cultural practices promoting new growth are also an adjunct of control. By such a program the orchard can be brought back to a fairly normal state of health within three years.

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COMPATIBILITY TYPES ISOLATED FROM MYCELIAL MATS OF THE OAK WILT FUNGUS

Charles L. Fergus

The mycelial mats of Endoconidiophora fagacearum Bretz, which are found beneath the loosened bark of dead oak wilt trees, appear to be the logical source of inoculum for overland spread of the pathogen (2). Since this fungus is an hermaphrodite consisting of two cross-fertile, self-sterile compatibility types (3, 4), spermatization of one type by a strain of opposite compatibility is necessary before perithecia and ascospores form. Some mats bear ascospores in perithecia in addition to the large numbers of endoconidia. To date, perithecia have been found only on mats under bark which has already cracked and it has been assumed that such mats have been spermatized by spores of the appropriate compatibility carried by insects from other mats on nearby trees (1).

If mats bearing endoconidia of both compatibilities are produced on a single tree, perithecia might form more abundantly in nature than if endoconidia of only one compatibility type were formed. Insects that normally invade weakened and dead and dying oaks might act as spermatizers by mere chance in moving from one mat to another mat of the same tree. If however, only one compatibility type is formed, the insect must move from one tree to another to accomplish spermatization.

The purpose of this paper is to report results of the determination of the compatibility types isolated from single mycelial mats and from numerous mats formed on a single tree.

MATERIALS AND METHODS: To determine whether or not the hyphae, conidiophores, and endoconidia of a single mat are of the same compatibility type, 20 different isolations from the central furrowed pad and 20 from the sporulating mycelial portions were made from each of two mats.

To determine whether or not all the mats on a single tree are of the same compatibility type, isolations were made from 20 mats from each of six trees. Two isolations from the pad portion and two from the mycelial portion were made from each mat.

The isolations were made by picking off bits of the mycelial or pad portion with sterilized forceps and planting in malt extract agar.

The compatibility type of each isolate was determined by growing the cultures for 14 days on Nutramigen agar in petri dishes. The cultures were then spermatized by atomizing conidia of known compatibility type onto the culture. When the two types brought together were of appropriate compatibility, fertile perithecia formed within 48 hours.

EXPERIMENTAL RESULTS: All isolates from single mats were of the same compatibility type. The isolates from the mats formed on a tree were all of the same compatibility type. Mat isolates from tree Nos. 1, 2, 3 and 4 were of A compatibility and from tree Nos. 5 and 6 were of B compatibility type.

The isolates from the pad portion of mycelial mats grew in a similar manner to those made from the sporulating mycelial portion. They produced abundant spores and when spermatized with endoconidia of appropriate compatibility type formed abundant fertile perithecia similar in all respects to those developing in cultures of Encodonidiophora fagacearum made from infected oak twigs and from the sporulating mycelial portion of the mat.

DISCUSSION AND SUMMARY: Since all of the mats formed on each of the trees tested were of the same compatibility type, it appears logical to assume that only one compatibility type mycelium was present in the wood of the infected tree. This, therefore, offers further evidence that very few infected trees contain mycelium of both compatibility types of E. fagacearum (1, 4).

Although based on results obtained from a small number of trees, this study further strengthens the hypothesis that some agent, an insect perhaps, is necessary for spermatization and subsequent perithecial formation in nature. The agent apparently must come from mats of appropriate compatibility from nearby trees (1).

In addition, these studies offer additional proof that the pads are a growth form of E. fagacearum (5) since cultures from them developed typical endoconidia, perithecia and ascospores.

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SCRUB OAK SUSCEPTIBLE TO OAK WILT

Charles L. Fergus and William L. Yount[1]

Endoconidiophora fagacearum Bretz, the fungus that causes oak wilt, has been isolated from a wilting scrub oak, Quercus ilicifolia Wang. The infected tree was found in Bedford County, Pennsylvania in an area called "The Bedford Narrows" by Mr. Arthur R. Jeffery, an inspector with the Pennsylvania Department of Agriculture. "The Bedford Narrows" is a remarkable area of about three acres in extent within which the oak wilt fungus has been isolated from wilting red, white, chestnut, laurel, and scrub oaks. None of these trees were within root grafting distance of wilt trees so it is assumed that infection resulted from overland spread.

The foliage symptoms observed on scrub oak were similar to those developed in wilting red oaks. Defoliation of partially discolored leaves had occurred by mid-August. The sapwood of twigs showed little or no discoloration. There were no wilting oaks within root grafting distance of the scrub oak.

The discovery of oak wilt affecting scrub, or ground, oak extends the known natural suscept range of the disease. Scrub oak is not a commercially important timber tree, but it has considerable economic importance in soil conservation and wild life.

It is usually found growing on rocky hillsides, sandy plateaus and mountain tops. Extensive areas of burnt-over land in Pennsylvania have been over-grown by this species. Since it grows upon the most exposed and inhospitable sites it helps prevent soil erosion, shelters the forest-floor, and enriches the soil with accumulations of humus eventually enabling the establishment of other tree species.

In areas in which it grows in abundance it is the most important mast producer for wild life. According to Sharp[2] it is an exceedingly heavy and consistent acorn producer. In addition it provides an important ground cover for wild life, particularly for turkey and deer. The loss of scrub oak would be of tremendous importance to wildlife management and soil conservation.

The discovery of oak wilt affecting scrub oak increases the number of species of oak found infected in nature in Pennsylvania to eight. Of the 16 species of Quercus native to Pennsylvania, the following have been found infected in nature: Quercus alba (white), Q. prinus (chestnut oak), Q. rubra var. borealis (Northern red), Q. palustris (pin), Q. coccinea (scarlet), Q. velutina (black), Q. ilicifolia (scrub), and Q. imbricaria (laurel oak).

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[2]Sharp, W.M. Data on oak mast production. (Unpublished). Pennsylvania Cooperative Wildlife Research Unit, State College, Pennsylvania.

THE RELATION OF OAK WOUNDS MADE DURING SPRING WOOD FORMATION TO TRANSMISSION OF OAK WILT

Arthur R. Jeffery[1]

Field observations on the establishment of Endoconidiophora fagacearum in wounded trees seem to indicate that wounds made during the period of spring wood formation are of considerable importance in the primary spread of oak wilt. As a result of the Pennsylvania Oak Wilt Survey in 1951, it was noted that 13 out of 15 positive infection sites were associated with some type of wounds on the trees. Again in 1952, it was observed that a large number of infected trees were wounded in some manner by pipeline, wireline, or highway construction, logging operations, or by lightning strikes. Of the 164 known disease areas, 108 contained wounds. Also in 1952, of a row of 19 small red oaks blazed with an axe for the purpose of marking a logging trail, 17 were found to be affected by wilt. This trail was blazed during the last week of April, and wilt was observed in mid-July.

Because of the observations made in 1951 and 1952, an attempt was made during 1953 to correlate the time of wounding and type of wound with incidence of the disease in single trees and second year infection sites.

Examination of such infections has disclosed the following:

Infections following lightning injury	- 6
Infections following pruning damage	- 1
Infections following damage by pruning and climbing spurs	- 8
Infections following storm damage	- 3
Infections following damage by climbing spurs	- 1
Infections following damage by logging operations	- 81
Total wound infections oberved to date	- 101

By questioning the persons responsible for the wounding or by careful examination of growth rings, it was determined that in every case the wounding was done during the period of spring wood formation. This period in Pennsylvania in 1953 extended from the last week in April through the first week in June.

Of considerable interest was a row of scattered trees along a power line that had been trimmed, by workmen using climbing spurs, on May 18, 1953. Of 9 red oaks trimmed, 8 showed wilt during July. On each of these several limbs 2 or 3 inches in diameter had been sawed off, in addition to the puncture wounds made by the climbing spurs.

All of the trees included in the tabulation above were located in areas where active spore mats of the disease were known to have existed during the period of spring wood formation. Numerous sap feeding insects commonly associated with spore mats were known to have been active at the same time.

During the winter of 1952-1953, ice storms were responsible for breaking the tops out of many oak trees in the general area of heavy infestation. However, not a single new 1953 infection has yet been found in any of these storm damaged areas. Examination of several hundred acres where logging operations have been continuous over a two-year period, in the center of the heavily infested area of Pennsylvania, has yielded valuable information. Large numbers of injured red oaks were present throughout this operation site, but out of 27 wilt trees examined, every one had been wounded during the spring wood formation period. Other trees, wounded during summer, winter, and early spring in the same area, failed to show any wilt symptoms.

In another area where trees were trimmed along a utility line in early August 1953, a total of 160 red oaks and 5 white oaks injured by pruning were examined in early October. No trace of wilt had developed.

The type of wound seems to make little difference as long as the bark is injured sufficiently to expose the cambium.

In Pennsylvania, a majority of wilt infections occur on or near crests of ridges. Lightning probably plays an important part in this spread.

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POWDERY MILDEW OF SMALL GRAINS IN INDIANA IN 1953

John F. Schafer and Ralph M. Caldwell

Powdery mildew (Erysiphe graminis DC.) developed abundantly and early on winter wheat throughout Indiana in 1953. Environmental conditions present included a very mild winter in 1952-53 and increased use in the State of mineral fertilizers, especially nitrogen. Vigo, the leading wheat variety in Indiana, is highly susceptible to mildew. In the wheat breeding nursery at Lafayette, mildew was particularly abundant in the early planted nurseries (planted in mid-September 1952), in which large plants had become established in the fall and in which there was vigouous early growth in the spring.

Resistance to powdery mildew derived from Hope-Hussar C. I. 11532 Selection 52 provided near-immunity this year in experimental plots of C. I. 12557 at six locations in the State. This is of interest in relation to the experience in southeastern United States with Hardired C. I. 12183 carrying resistance from the same parentage. The latter variety was originally highly resistant when released in 1940 but since 1945 has been severely attacked by specialized races of mildew.[1]

In the winter barley nursery at Lafayette which was also well-established in the fall and vigorous early in the spring, powdery mildew was very scarce early in the season and did not become abundant until shortly before heading. The later leaves never became heavily infected. The barley at Lafayette was isolated by several hundred miles from any major acreage of winter barley for a source of inoculum, whereas there are extensive wheat acreages throughout most of Indiana.

Powdery mildew could not be found on winter oats early in the season, but by mid-June it was abundant in the Lafayette nursery although developed less vigorously than on either wheat or barley. This is believed to be the first report of powdery mildew on oats in the field in Indiana. No mildew was observed on spring oats. This plot of winter oats, as in the case of the barley, was isolated from a major acreage of winter oats.

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EXTENSION WORK IN PLANT PATHOLOGY[1]

Royal J. Haskell

Our early settlers brought with them from abroad what information they had about plant diseases and their control. The facts were indeed meager -- at that time little was known about the diseases.

Not until 1853 -- some 200 years later -- was it proved that fungi could cause plant diseases. In 1879-1881 bacteria were established as causes of other plant ailments. Only in 1888 was proof forthcoming of the infectious nature of plant viruses.

So, in the early history of our country, plant diseases were attributed to unknown causes, acts of Providence, and the vicissitudes of the weather, and they took their toll largely unchecked.

With the establishment of institutions of higher education, especially the State land-grant colleges (July 2, 1862), with the organization of the Department of Agriculture (May 15, 1862), and with the extension of Federal aid to the State experiment stations (1888), centers for the teaching and investigation of plant diseases were set up.

In the United States Department of Agriculture the first plant pathology unit, the section of mycology in the division of botany, was organized in 1885. The first independent department of plant pathology was established in 1907 in Cornell University.

The first organized State extension project in plant pathology seems to have been that of the New York State College of Agriculture, which appointed M. F. Barrus to be assistant professor of extension work on September 20, 1911. New York then had no county agents. Professor Barrus lectured at farmers' institutes and granges, staged exhibits at fairs, gave talks and demonstrations on agricultural trains, and taught at extension schools.

Next to give official attention to extension work in plant pathology was Wisconsin. Dr. R. E. Vaughan was authorized to visit farmers and give spraying demonstrations in connection with his studies of blight of canning peas during the summers of 1912 and 1913. He was appointed extension plant pathologist on July 1, 1915.

Cooperative extension work was established on a country-wide basis by the passage of the Smith-Lever Act, May 8, 1914. It enabled other State extension services to appoint specialists and give plant diseases closer attention.

Today we have the cooperative extension service that assists the farmer, homemaker, and rural youth with many problems. It is a cooperative, educational partnership between the State land-grant colleges and the United States Department of Agriculture and reaches into every agricultural county in the Nation.

The county representatives -- agricultural agents, home demonstration agents, and 4-H club agents -- work with people, especially those in rural areas, to help solve problems and develop programs for improvement. They are the mouthpieces by which research information from the agricultural colleges and the Department is extended. They are also the earpieces by which the problems and experiences of the farm and home are relayed back to the colleges and the Federal Government.

On June 30, 1952, there were on the county staffs 3,421 agricultural agents, 1,838 assistant agricultural agents, 2,938 home demonstration agents, 754 assistant home demonstration agents, 546 boys' and girls' club agents, and 102 assistant boys' and girls' club agents.

They and the directors, leaders, and specialists on State staffs made a total of 12,593 county and State extension workers. Helping them immeasurably is a great body of volunteer local leaders, who give their time and energy to carrying forward the objectives with boys and girls, men and women.

To provide for this staff approximately 77 million dollars from Federal, State, and local funds was expended during the fiscal year that ended June 30, 1952.

For leadership in extension work in plant diseases in the States and Territories, the State extension services rely chiefly on the departments of plant pathology in the agricultural colleges and universities. In 26 of the States the extension services employ extension specialists in plant pathology to devote some or all of their time to it. Several States employ more than one such specialist. In 1953 there were 48 extension specialists in plant pathology, of whom 23 gave

[1]This article was prepared for the 1953 Yearbook of Agriculture but circumstances prevented its use therein. It gives such a good account of the subject that we believe it should be made available. --P. R. M.

full time and 25 part time to extension. Among them were 35 general plant pathologists, who worked on diseases of all crops; four specialized on diseases of fruits; four on diseases of vegetables; two on diseases of cereal and forage crops; and three on diseases of ornamentals and special crops.

In cooperation with others, the specialists plan extension programs in their special subjects based on the problems and programs as developed by the people themselves on the farms and in the counties. They furnish information to county and community planning groups. They check up on results. They also are teachers, who represent their institutions in the field and are responsible for presenting accurate information on plant diseases and their control.

The specialists and county agents work together in diagnosing plant disease problems and recommending counter measures. They visit farms, examine local situations, and discuss problems with growers. They give demonstrations of results, hold meetings, conduct tours, and give out information by means of circulars, press, radio, and television. They train local leaders individually and in groups. Operators doing custom spraying in potatoes in States like New York and Pennsylvania, for instance, are sometimes brought together to discuss the improvement of their services to farmers. Nebraska has had an annual conference and school for operators of airplanes that are used for dusting and spraying crops.

The examination of specimens sent to the divisions of plant pathology in the colleges and the handling of inquiries regarding plant diseases are functions largely of the extension plant pathologist. Some of the divisions have clinics, at which members of the staff examine and diagnose the cases represented by the specimens and descriptions sent in. All the pathologists thus are kept informed as to the diseases that are showing up in the State. The plan also helps train graduate students.

The extension pathologist during a year's work examines a lot of material and writes many answers to inquiries. Some of these calls for help come from county agents, others from home owners and farmers. Some are so urgent they require emergency trips to study situations and assist in making plans to meet the problems. Plant diseases, being greatly affected by weather conditions, vary greatly in incidence from year to year, therefore, although careful plans of work are made each year in advance, it is often impossible for specialists to follow such plans closely because of emergency situations that cannot be predicted.

The specialist conducts another kind of clinic in the field as part of a meeting or as a special event. Agents notify growers as to the time and place that they can consult the "plant doctor." They can then bring in samples of their sick plants for diagnosis.

Every specialist makes surveys or check-ups in fields and orchards. He usually singles out a special disease or crop for special attention. Often the surveys are in the nature of studies to determine the success of control measures -- particularly in fruit orchards to learn more about the effectiveness of recommended spray schedules, or in crop fields or vegetable plots to gather needed facts. Sometimes new diseases appear and information is needed promptly on the extent and seriousness of the infestation.

The Extension Service cooperates with agronomists, horticulturists, and others of the experiment stations to encourage farmers to adopt new, disease-resistant varieties. They do this as soon as new varieties are developed and released, by demonstrating their characteristics to farmers so that their value can be determined locally.

For example: Demonstrations of the control of potato diseases through the use of resistant varieties have been given in Pennsylvania each year. Nineteen demonstrations of new varieties were conducted in different places in 1951 to show farmers the superiority of some of the newer kinds with respect to their resistance to late blight (Phytophthora infestans), ring rot (Corynebacterium sepedonicum), and scab (Streptomyces scabies). In some varieties the factors for resistance to all three diseases have now been combined with high yield and good marketing qualities. In the demonstrations the old sorts are planted along with the new ones to show differences. Each year the new varieties need to be demonstrated so that farmers are informed of the latest developments.

Demonstrations of the control of disease by resistant plants are exemplified by experiences in Virginia, where black-shank (Phytophthora parasitica var. nicotianae) of tobacco was introduced on plants from other States. Reports from county agents have indicated that the number of farms known to be infested with black-shank has increased about 100 percent each year since 1949.

S. B. Fenne, an extension pathologist, reported:

"In cooperation with county agents and the agronomy department, 63 demonstrations were set up in 20 counties. Forty-one were in the flue-cured area. Fourteen were in the fire-cured area and eight were in the sun-cured area. In all of them, a few of the old, standard,

recommended varieties and several of the new disease-resistant ones were planted in plots, carefully marked by stakes and signs. Field meetings were held at most of the demonstrations. Large crowds of farmers attended, many of them bringing disease specimens for diagnosis. At the meetings, we were able to demonstrate the growth and behavior of many new varieties, several of which must be grown on those farms infested with black-shank, Granville wilt (Xanthomonas solanacearum), or mosaic (virus). A total of 43 meetings at these result demonstrations were held, with an attendance of more than 1,000."

Spray information services for fruit growers are conducted by extension workers in many States. Growers of apples, peaches, cherries, grapes, citrus, and other fruits get timely information to guide them in their spraying operations. The pioneer in such service was New York, whose extension pathologists and entomologists, placing emphasis on food production during the First World War, sent trained observers to 13 fruit-growing counties. Now the assistant county agents in the fruit counties serve as special observers and advisers. They make notes on the condition of the fruit buds and on the development of the apple scab and other fungus pathogens, and report regularly to the extension fruit pathologist in Ithaca. He receives daily and long-range weather forecasts from the Weather Bureau. He adds that information to his own observations, prepares spray notices, and sends them to the counties. Because timeliness in applying sprays for apple scab (Venturia inaequalis) is important, the information needs to be handled fast. Telephone relays get the word around to the county representatives, who in turn notify the growers by telephone or daily papers or radio.

The Ohio spray service, established in 1925, was set up on a centralized system. The extension pathologist and entomologist at the University make the recommendations. Voluntary reporters are enlisted from the various fruit sections. At stated intervals they telegraph information on the stage of the fruit buds and send facts and samples to show the condition of the scab and other fungus parasites. On the basis of forecasts from the Weather Bureau, the pathologist makes up his spray notices, which are telegraphed to key radio stations. Growers depend on the regular broadcasts to guide them.

Virginia and West Virginia established their spray services in 1922. The Virginia service largely depends on post card notices. The West Virginia service uses the daily newspapers to disseminate the spray warnings.

These spray services in the several States are usually conducted cooperatively by extension specialists in plant pathology, entomology, and horticulture. The responsibility varies with the State and the season of the year. In winter the specialists and research men go over the fruit spray recommendations and revise the popular bulletins or leaflets, which give the materials to use, dilutions, rates, and approximate time of application. It then remains for the spray service to furnish the information as to the precise timing and the variations in recommendations that will be necessary on account of seasonal and other conditions. Extension specialists and county agents visit many orchards during the growing season, check the results, and discuss special problems with growers. Often demonstrations in the orchards show the value of certain sprays or techniques.

To avoid confusion from different recommendations along State borders, men in charge of the spray services in groups of States sometimes meet to reconcile differences and arrive at more or less standard recommendations. One such is the Cumberland-Shenandoah conference of fruit workers, which brings together men from Virginia, West Virginia, Pennsylvania, Maryland, and New Jersey. Others are the New York-New England spray conference and one for fruit States in the Ohio-Mississippi Valley.

Growers appreciate such detailed information. Some 18,000 growers receive letters about spraying in Pennsylvania. In that State, where some 11,000 apple growers receive the service, it was estimated in 1950 that more than 3 million bushels were added to the apple crop by control of diseases.

The use of disease-free seed is important in avoiding losses. Inspection and certification of seed crops are conducted mostly by State crop improvement associations and State departments of agriculture, but specialists in plant pathology and county agents help growers of certified seed to meet the standards. The production of certified seed potatoes involves more technical assistance with respect to diseases than does any other crop. Potato growers are given information that helps them recognize virus, bacterial, and fungus diseases and how to control them. The techniques of tuber-unit planting, roguing, and testing farmers' samples for virus diseases in advance of planting are given attention.

Many farmers use chemically treated seed in an effort to control seed-borne diseases.

A survey by a company operating elevators in the spring wheat area in 1952 indicated that 66 percent of the wheat, oats, barley, and rye acreage in Minnesota, North Dakota, and South

Dakota was sown with treated seed.

The development of new chemicals and processes has made tests and demonstrations by extension pathologists and agents necessary in the field. Dust chemicals are giving way to slurry and liquid treatments, which eliminate much of the hazard and annoyance to operators. More and more of the treatment is now being performed at elevators, seed houses, and other cleaning and treating stations, or by portable equipment.

In Iowa about 300 machines were available for cleaning and treating seed in 1951. In Nebraska 102 portable or stationary units were reported in 1951. They treated 836,000 bushels of seed grain in 1951, compared to 378,000 bushels in 1950. Custom cleaning and treating was done in Kansas at some 260 stationary plants and with 115 portable machines. In 1951 about 26 million bushels of cereal seed were treated with the commercial outfits in Kansas.

In extension work on the control of cereal diseases, many methods are employed: Radio broadcasts, news articles, leaflets, bulletins, meetings, demonstrations, exhibits, posters, and other means and agencies. Surveys are made to determine the extent of the losses and where they are occurring and to determine the effectiveness of the practices.

The chemical treatment of cottonseed, a major development since 1935, reduces seed decay and seedling blight, improves stands, and tends to give better yields of seed and lint. In some States it is estimated that as much as 60 percent of the planting seed is treated.

Extension pathologists are feeling their way with respect to the practice of treating seeds of grasses and legumes with the idea that treatment may bring about better stands of healthier plants. We have evidence that many times the stands of those forage crops can be improved, but more testing and demonstration need to be done under different conditions before it can be recommended as a general practice. Demonstrations of results, in which various chemicals are used at different rates, therefore have been conducted on farms to determine the effects under local conditions.

An example of accomplishment in controlling an important plant disease over a number of years has been recorded by L. E. Melchers in the bulletin, Bunt Control in Kansas, A Thirty-five Year Coordinated Program, published by the Kansas Agricultural Extension Service in 1950. By persistent effort, bunt (Tilletia sp.) of wheat in Kansas has been steadily reduced while the acreage of wheat has increased. The average annual loss from the disease between 1914 and 1928 was estimated at 4,529,000 dollars compared with 916,000 dollars during the 15 years from 1929 to 1943. That reduction has been due to the adoption of improved State-wide control practices worked out by research and introduced into practice largely by extension workers in a long-time, intensive program.

A feature of the campaign was a 5-year Wheat Belt program that started in 1925. Extension pathologists and other specialists concerned with wheat cooperated with the railroads in running wheat trains in the Wheat Belt. Meetings and demonstrations were held at stations where the trains stopped. Specialists gave talks and demonstrated the methods of seed treatment, using copper carbonate dust, which was recommended at that time. County agents arranged to have farmers plant samples of treated and untreated wheat. Leaflets were passed out. Cooperating with the college and the railroads were the Kansas Crop Improvement Association, Kansas State Board of Agriculture, Southwestern Wheat Improvement Association, chambers of commerce, newspapers, and banks.

The drive ended the epidemic of wheat bunt in Kansas. The practices that were recommended were effective seed treatments with chemical dusts, the use of smut-free seed, suitable planting dates, and bunt-resistant varieties. Since 1930 the same measures have continued to be stressed, but details have varied as new fungicides, equipment, and varieties have been developed.

A plant disease warning service was established in 1947 following a severe outbreak of late blight of tomatoes. It has helped growers to time their spraying operations so as to control the blight. The service also includes similar information on potato late blight, tobacco blue mold (Peronospora tabacina), and downy mildew (Pseudoperonospora cubensis) of cucurbits. More recently it has been extended to give warnings regarding possibilities of outbreaks of other important diseases.

Headquarters of the warning service is the Plant Disease Survey of the Bureau of Plant Industry, Soils, and Agricultural Engineering, Plant Industry Station, Beltsville, Maryland. Farmers, county agents, or other field men who discover plant diseases report their findings to the extension plant pathologist or another pathologist in the State, who relays the information to the central plant disease survey clearing office. There summaries are prepared and warning letters are sent back to State pathologists. County agents, field men, and farmers

also are informed. Reports are sent to dealers in fungicides so that they can be ready to supply spray materials wherever they are needed.

Extension plant pathologists keep in touch with industry to check supplies, new formulations, and recommendations. Meetings, schools, or regular courses with representatives of manufacturers and dealers are sometimes arranged either at the State college or perhaps on a district basis.

An example: In West Virginia, in an effort to improve crop production in 1943, each county agent called a meeting of agricultural workers in his county and with them made plans to visit dealers in fungicides and insecticides. The purpose of the visits was to discuss the materials recommended by the State college of agriculture, make an inventory of the dealers' stocks, and recommend chemicals that would be most useful in the production program. Bulletins giving the recommended chemicals for garden insect and disease control were given the dealers. Posters were put up in stores so that clerks and customers could determine which kind of chemical was needed for the problem at hand. Dealers said the posters in the stores increased their sales as much as 25 percent. They stocked the recommended materials and customers got better service. The program has been continued with little effort. Retailers and manufacturers now take the initiative in keeping in touch with the agents and the West Virginia Extension Service.

In carrying forward their projects, 4-H club members learn that plants as well as animals have diseases. Plant pathology is a rather advanced subject for a club project by itself, but in their regular projects with fruits, vegetables, cereals, and other crops members gain knowledge concerning the nature and control of plant diseases. Plant pathology is therefore included as a part of projects in agronomy and horticulture. The extension pathologist usually assumes responsibility for the information and instructions given out in circulars, handbooks, and other 4-H club publications.

Among the demonstrations given by 4-H teams are some that have to do with seed treatment, making a home-made seed treater, mixing and applying sprays, and controlling a particular disease. Illustrated lectures, study of specimens, identification contests, and tours through fields, gardens, and forests are among the 4-H camp projects that pertain to plant diseases. They help introduce many of the 2 million 4-H boys and girls to the subject of plant pathology.

County agents reported that in 1951 they helped 106,660 farmers control diseases of corn; 119,213 farmers with diseases of wheat; and 126,817 with diseases of other cereals. With other crop ailments farmers were assisted as follows: Legumes, 92,795; pastures, 39,085; cotton, 187,036; tobacco, 177,555; potatoes and other vegetables, 343,962; fruits, 184,113; and other crops, 67,755.

COOPERATIVE EXTENSION SERVICE

BRIEF OUTLINE OF PERSONALITIES, EVENTS, AND TRENDS, IN PLANT PATHOLOGY IN THE UNITED STATES[1]

Paul R. Miller

Many men have been active in organizing and developing phytopathological work in the United States. A few of them are listed here.

F. L. Scribner, the first Federal phytopathologist, introduced bordeaux sprays into the United States in 1885.

B. T. Galloway was the first chief of the Bureau of Plant Industry, United States Department of Agriculture; he was unusually successful in organizing and developing the pathological work in the bureau.

Erwin F. Smith, the father of the science of bacterio-phytopathology, was widely known for his studies on the relation of crown gall of plants to human cancer.

J. C. Arthur was considered the world's outstanding authority on plant rusts.

T. J. Burrill was the discoverer of bacterial plant diseases and the first teacher of plant pathology.

G. F. Atkinson was the author of several classics in phytopathology, including damping-off of seedlings and diseases of cotton.

L. R. Jones was noted for his studies on the etiology of potato blights, soft rot in vegetables, and wilt resistance in cabbage in relation to environmental factors. He also trained and inspired many of the leading plant pathologists of today.

H. L. Bolley was the first to make practical use of the fungicidal properties of formaldehyde. He was an advocate of the seed and soil infestation theory as the explanation for the decreasing yields on flax and wheat lands in the West.

W. A. Orton pioneered in the development of plants resistant to diseases. Between 1899 and 1909, by selection and breeding, he obtained strains of cotton, melons, and cowpeas resistant to Fusarium wilt fungi. His results stimulated widespread search for disease-resistant strains in many other cultivated crops.

H. H. Whetzel organized the first department of plant pathology and was known as an outstanding teacher of the science.

M. B. Waite was the first to prove insect transmission of a bacterial disease, with his studies of fire blight (Erwinia amylovora) of pear, carried by the honey bee. He contributed much to our knowledge of diseases of fruit trees.

B. M. Duggar wrote the first American textbook in plant pathology in 1919.

E. C. Stakman is a chief contributor to the knowledge of the importance of biotypes within morphological species of fungi, and of causes of variability in pathogenic fungi as it relates to breeding for disease-resistance in plants.

Among the outstanding discoveries or events that have marked the progress of plant pathology in the United States are:

The first courses in plant pathology in American universities were given at the University of Illinois (1873) -- taught in connection with botany; Harvard (1875) -- taught as a special subject; Cornell (1907) -- first department of plant pathology established; Wisconsin (1909) -- second department of plant pathology.

The organization of the State Agricultural Experiment Stations followed enactment of the Hatch Act in 1887. That act has been supplemented by the Adams Act of 1906, the Purnell Bill of 1925, and the Jones-Bankhead Act of 1935. Increased emphasis has been put on phytopathology as a result; more than 1,500 teachers, investigators, and extension men were engaged in plant pathology in 1953 in the United States.

Proof of the relation of bacteria to the fire blight of apple and pear, the first proved bacterial disease of plants was given by Thomas Burrill, University of Illinois, in 1879-1881.

Proof was given by Erwin F. Smith and C. O. Townsend, of the Department of Agriculture, of the bacterial origin (1907) of crown gall of various hosts and the assignment of the pathogen to a specific organism, Pseudomonas tumefaciens (now Agrobacterium).

The study of two important epiphytotics stressed the economic importance of plant diseases. The chestnut-tree blight (Endothia parasitica), a most virulent and devastating disease of chestnuts (1906 to present); citrus canker, a bacterial disease (Xanthomonas citri) which appeared

[1]This article was prepared for the 1953 Yearbook of Agriculture but circumstances prevented its use therein.- P. R. M.

first in Texas (1909-1910) and later spread to the other Gulf States, from which it has since been eradicated.

The American Phytopathology Society was organized in 1909 and its journal, Phytopathology, was founded in 1911.

The Congress enacted in 1912 the National Plant Quarantine Act, designed to exclude foreign insect pests and plant diseases. A Federal horticultural board was created to administer the Act.

The first proof of insect transmission of potato mosaic in 1908 led to rapid increase in our knowledge of the virus diseases of plants, including other mosaics and leaf roll.

Appropriation by the Congress of funds for the control of white pine blister rust, a heteroecious rust (Cronartium ribicola) passing from currants and gooseberries to the white and other five-needled pines (mainly since 1915) was a milestone in large-scale efforts against epidemics.

A campaign for the eradication of the barberry as a means of preventing the epiphytotics of stem rust of wheat was begun in 1917 and has become even more important since the role of barberry in the origination of new races of stem rust (Puccinia graminis) became known.

The introduction and development of Extension work in plant pathology was stimulated by the Smith-Lever Act of 1914.

The Dutch elm disease (Ceratostomella ulmi), which threatens the extermination of the American elm, reached the United States in 1930.

W. M. Stanley reported in 1935 the discovery of the crystalline protein nature of tobacco mosaic virus; the finding, although modified in details by later work and other workers, was a great advance in the understanding of the nature of viruses.

Notable practical applications include:

The use of formaldehyde to control seed-borne diseases by H. L. Bolley of North Dakota (1897).

Emphasis on the production of immune or resistant varieties of plants for plant disease control, following the work of W. A. Orton on the fusarium wilt of cotton, cowpeas, and melons (1899-1909).

The demonstration of the effectiveness of liquid lime-sulfur as an insecticide and fungicide, and its use in the control of apple scab, by A. B. Cordley of Oregon and C. V. Piper of Washington (1906-1908).

Proof of the effectiveness of dusting with finely powdered fungicides, especially finely ground sulfur and powdered lead arsenate, as a substitute for spraying (Cornell University, 1913-1917).

Introduction of the copper carbonate dust treatment of wheat for bunt (Tilletia spp.) (1921), and the more recent demonstration of the general application of other dust disinfectants and protectants for the control of seedborne disease.

The widespread application of organic mercury seed disinfectants and protectants, especially the dry materials and those used in suspensions, with treating time reduced to 1 or 2 minutes.

Addition of numerous organic chemicals and of antibiotics to the ranks of practical and experimental control materials for plant pathogens.

The utilization of long-range weather predictions and epidemiological research in forecasting and controlling plant diseases.

One cannot be certain about future trends in any line of work, but emphasis in plant pathology very likely will be given to the following topics:

Eradicant fungicides: Further application of such fungicides as have been utilized to control apple scab (Venturia inaequalis), cherry leaf spot (Coccomyces hiemalis), and downy mildew (Peronospora tabacina) of tobacco.

Breeding for resistance: Obtaining productive varieties of plants adapted to local areas and resistant to major diseases.

Increasing knowledge concerning the nature of viruses and the devising of methods for their classification, diagnosis, and control.

Improved and additional methods for the chemical treatment of soil and seeds.

Studies concerning the biology of the soil as an aid in controlling soil-borne fungi.

New techniques in genetics, such as changing the chromosome number, as has been done by the use of colchicine and radiation, for the purpose of developing breeding stock resistant to disease.

Application of forecasting techniques to a greater number of diseases and the correlation of research on weather and microclimate in relation to development of disease.

The use of radioactive elements for tagging plant pathogens in order to study their spread over great distances.

Research leading to the use of systemic fungicides -- chemotherapy -- in the control of plant diseases.

DIVISION OF MYCOLOGY AND DISEASE SURVEY

UNUSUAL RECORDS AND OTHER BRIEF NOTES ON PLANT DISEASES

LEAF RUST OF MERION BLUEGRASS IN NEBRASKA

By W. W. Ray

On August 18, 1953, Dr. H. L. Weaver of the Department of Botany at the University of Nebraska told me about a severe yellowing condition in his lawn of Merion bluegrass. He had seeded the grass in early spring of 1953. Examination of specimens of the yellowed grass disclosed a heavy infection by the uredial stage of Puccinia rubigo-vera (DC.) Wint.

The area planted to Merion bluegrass was rectangularly shaped and measured about 45 by 95 feet. Weeds of various kinds were prevalent on the south two-thirds of the area, whereas the north one-third had been carefully weeded by hand. It was in this weeded portion that the rust was so heavy and where the yellowing was very evident. Although some rust infection existed in the weedy area, the plants viewed from a distance did not present the distinctly yellowed appearance that those in the weeded area did. Surrounding this Merion bluegrass plot are lawns planted to Kentucky bluegrass which were found to be free of any rust infection.

The weather in Lincoln prior to the outbreak of the rust infection consisted of fairly cool nights with heavy dews, and warm, sunny days having a relatively high humidity. This combination of conditions coupled with frequent watering apparently favored the development of this specific outbreak of leaf rust.

The record of this occurrence is made because of the greatly increased interest in the use of Merion bluegrass to replace the usual Kentucky bluegrass in lawns. Several unconfirmed reports of leaf rust of Merion bluegrrss have recently come to my attention, but I have not had an opportunity to examine the plantings. Subsequent epiphytotics of this rust may not occur again for several years here, but the plantings will be kept under observation in future summers.

AGRICULTURAL EXPERIMENT STATION LINCOLN, NEBRASKA

CONTROL RECOMMENDATION CHANGES FOR LONDON PLANE CANKER STAIN DISEASE

By Edgar G. Rex and James M. Walter

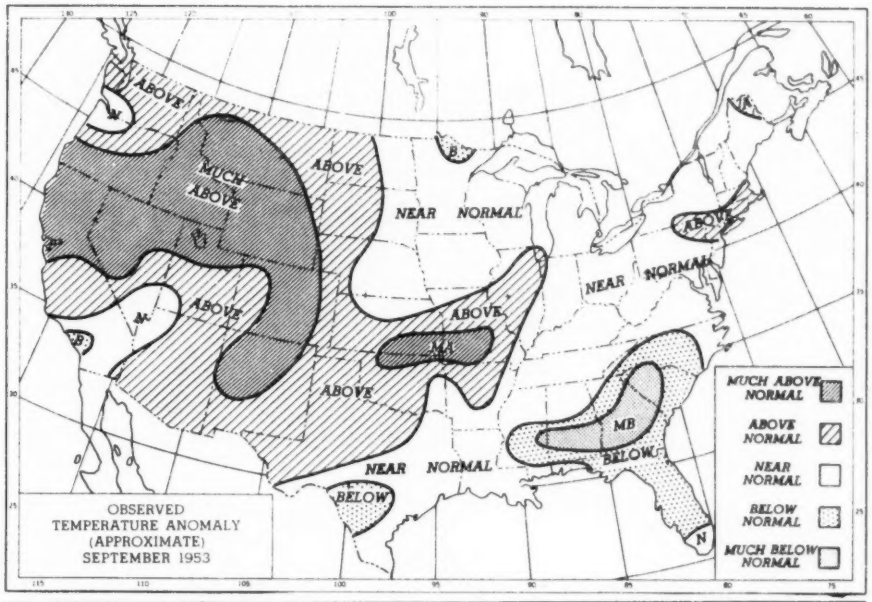
Circular No. 360 (1946) and its first revision (1949) of the New Jersey Department of Agriculture, Trenton, outline a calendar period, December 1 to February 15, during which London plane was believed to be immune from infection from pathogen-contaminated, unsterilized pruning tools. Investigations and extended field observations since 1949 have yielded information that this premise is not consistently dependable and hence of questionable security in any organized plan to control or eradicate this disease. Therefore, the authors have decided to amend the afore cited circulars, recommending the sterilization of all tools used in the pruning and removal of London plane trees throughout each month of the year. Copies of the amended circulars will be sent upon request to the New Jersey Department of Agriculture, Trenton 1.

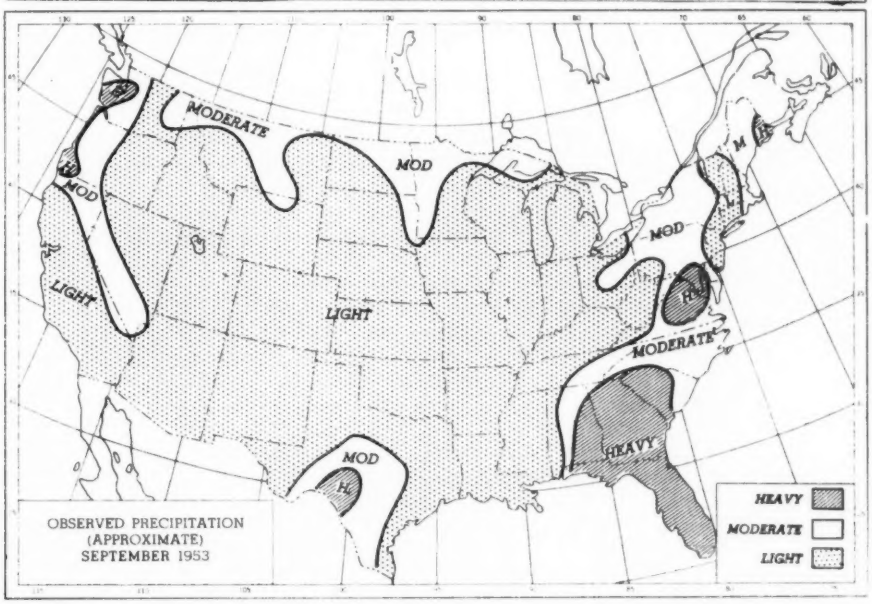
NEW JERSEY DEPARTMENT OF AGRICULTURE, TRENTON 1.

SOME CORRECTIONS

On page 500 of the October 15 issue, the parenthesis at the end of reference No. 12 should read "(Reprinted as Florida Dept. Agr. Bul. 131)", not Florida Agr. Exp. Sta. Bul. as given.

On page 496 (In This Issue), the sixth item, listing the article by John R. Cole, should read pecan orchards, not peach.





The terms used in the accompanying maps, which define the ranges of temperature and precipitation, are numerical class limits. These are based on a statistical analysis of past records through which is determined the normal frequency of occurrence of temperatures and precipitation at various times of the year for different locations. For temperature the classes above, below, and near normal are so defined that they each normally occur one-fourth of the time; much above and much below normal, one-eighth of the time. Precipitation is depicted in terms of light, moderate, and heavy, each class normally occurring one-third of the time and thereby having equal probability of occurrence. These maps graphically represent only the general trends and give the country's weather picture at a glance. For quantitative studies, where monthly mean temperatures and actual precipitation records are needed for a given time and place, other publications of the Weather Bureau should be consulted. P. R. M.